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ABSTRACT

This basic core curriculum is part of a three-part series of instructional guides designed for use in teaching a course in highway maintenance equipment operation. Addressed in the individual units of the curriculum, after an orientation unit, are safety; basic math; basic hand tools; procedures for loading. lashing, and unloading equipment; principles of engine operation; preventive maintenance; trucks and attachments; and tractors, tractor attachments, and front-end loaders. Each instructional unit contains some or all of the following: performance objectives, suggested activities, information sheets, transparency masters, assignment sheets, job sheets, tests, and answers to the test and assignment sheets. (MN)

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Highway Maintenance Equipment Operator: Basic Core

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Vol I of 3

Highway Maintenance Equipment Operator:

Basic Core

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HIGHWAY MAINTENANCE EQUIPMENT OPERATOR:

BASIC CORE

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FORWORD

In 1981, as an effort to provide high-quality and uniform training materials, the Departments of Transportation in Oklahoma and Kansas and the New Mexico Highway Department entered into an agreement with the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, to develop a curriculum for equipment operators in highway maintenance. *Highway Maintenance Equipment Operator: Basic Core* is the first of three books printed as a result of the cooperative effort.

Within this consortium, administrators, supervisors, operators, and writers collaborated closely to produce materials that will provide each student with information and practical learning experiences directly applicable to maintenance operations. Whether the students are new employees, seasoned operators upgrading skills, or skilled operators reviewing procedures and using these materials for reference, they can appreciate the expertise of the people who created *Highway Maintenance Equipment Operator.*

The information in *Highway Maintenance Equipment Operator: Basic Core* has been selected to apply generally to highway maintenance training programs, and should be adapted and modified to coincide with departmental policy, specifications, and objectives.

It is my sincere hope that *Highway Maintenance Equipment Operator* will contribute to the development of a competent, safety-conscious workforce in maintenance operations across the country. Also, I hope that the dedication and active interest repeatedly shown by highway department representatives and employees carries through this publication from teacher to student and, through craftsmanship and care, to the highway-traveling public.

Francis Tuttle
State Director
State Department of Vocational Education

PREFACE

This curriculum was designed and prepared especially for equipment operators in highway maintenance. From gravel roads to multilane urban interstates, it is the responsibility of maintenance teams to maintain the roadways and rights-of-way in a condition safe for public and commercial use. Therefore, the purpose of these materials is to assist in training those teams in the safe and effective use of maintenance equipment.

Highway Maintenance Equipment Operator: Basic Core covers principles of engine operation, preventive maintenance, loading and lashing equipment, and basic math. The student is introduced to and trained in the operation of basic hand tools and the most frequently used equipment: trucks, tractors, and front-end loaders.

Safety cannot be too strongly stressed. We have made every effort to ingrain a safety-conscious attitude as the operator's first and foremost responsibility. Departmental safety manuals should be provided for each student and should be incorporated into the teaching of each unit.

We realize that departmental policy and available materials will vary with each training program, and we urge you to make whatever modifications are necessary and desirable to meet your own circumstances and objectives.

For the instructor, *Highway Maintenance Equipment Operator: Basic Core* offers a systematic presentation of information, written and applied exercises, and evaluation procedures. It is not intended that the units in this manual stand alone, but that they be enhanced with additional materials and with the instructor's own methods, experience, and enthusiasm.

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Joe C. Phipps, Ret.
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And thanks to Gary Ridley, Maintenance Supervisor, Division 4, Oklahoma Department of Transportation, for his many contributions in time, equipment, and personnel.

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It is with deep respect that I thank the employees of the Departments of Transportation in Kansas and Oklahoma for sharing their time and experience. They are skilled, dedicated, enthusiastic people who take pride in their work. It has been a pleasure and an honor to be associated with them.

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PRODUCTION STAFF

The production staff includes many people in Graphics Division whose names I do not know, but whose work I recognize and appreciate in word processing, art, and printing.

The fine talented hand of Kim Hale prepared the artwork for this project; Joan Henderson was the photographer; Claire Dickey processed film and photos.

Many thanks to Terra McCluskey and her editing staff, who have polished and finished my rough work. My time with them has been enjoyable and instructive. Thank you, Lynne Murnane, Susan Walker, Terri Perry, Jerry Weir, Sue Buck, Barbi Harrison, and Marla Hamilton.

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For their support and input, I am indebted to Joyce Sawatzky, Robert Hilley, and Sarah Mussett, who all worked closely with me at CIMC.

My deepest gratitude and appreciation go to Greg Pierce, who gathered support, personnel, and resource materials for *Highway Maintenance Equipment Operator.* He did a good job as teacher and supervisor, patching the rough spots in the road as I arrived at them. It has been a pleasure and a privilege to work with him.

And to you who are learning or upgrading your skills in highway maintenance, a sincere and special thanks. Few people have the opportunity I have had to know how important and demanding your work is. I am happy and grateful that I can contribute to your safety and growth.

Sandra D. Perky, Curriculum Writer
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USE OF THIS PUBLICATION

Instructional Units

Highway Maintenance Equipment Operator: Basic Core includes eleven units of instruction. The format used by the Oklahoma CIMC includes eight basic components which form a unit: performance objectives, suggested activities for the teacher, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to tests and assignment sheets. Depending on the specific objectives, transparency masters, assignment sheets, and job sheets may or may not be included in the unit of instruction.

All of the unit components "zero in" on measurable and observable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help him or her determine the following

A. Amount of material that can be covered in each class period
B. Skills that must be demonstrated
    1. Supplies and equipment needed
    2. Amount of practice needed
    3. Amount of class time needed for demonstrations
C. Supplementary materials, such as pamphlets and filmstrips, that must be ordered
D. Resource people who must be contacted

Performance Objectives (white pages)

Each unit of instruction is based on the performance needed for safe and effective equipment operation. Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching/learning process, it is important that teachers and students have a common understanding of the intent of the objectives. Following is a list of performance terms, their meanings, and behavioral synonyms that may have been used in this material.

A. Name--The individual supplies a name for objects, events, or people

Behavioral synonyms: Label, list, letter, record, reiterate, repeat, write

B. Identify--The individual selects a named, described, or pictured object by pointing to it, touching it, picking it up, or selecting it

Behavioral synonyms: Select, mark, match, choose, judge

C. State a rule--The individual communicates a relationship or principle that could be used to solve problems or perform a task

D. Apply a rule--The individual supplies an answer to a problem by using a stated relationship or principle

Behavioral synonyms: Solve, calculate

E. Describe--The individual relates sufficient characteristics or properties of an object or event so that a second individual will be able to state what is being discussed

Behavioral synonyms: Define, discuss, interpret, recite, tell how, tell what happens when

F. Distinguish--The individual selects an object or event from two or more that are easily confused

Behavioral synonyms: Discriminate, differentiate

G. Order--The individual arranges three or more objects or events in a sequence based on a stated property

Behavioral synonyms: Arrange, sequence, list in order, classify, divide, isolate, sort

H. Construct--The individual makes a physical object, a verbal statement, or a drawing

(NOTE: *Construct* is used when the finished product or result is important.)

Behavioral synonyms: Draw, make, build, design, formulate, reproduce, transcribe, convert, put together, compile

I. Demonstrate--The individual performs several operations necessary to carry out a specified process

(NOTE: *Demonstrate* is used when it is desirable to watch the student perform a task, one of the highest levels of student performance.)

Behavioral synonyms: Show your work, show procedure, perform an experiment, perform the steps, operate, remove, replace, turn off/on, (dis) assemble, (dis) connect

The objectives should be provided for students and stressed throughout the teaching-learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Prepare for each unit by deciding how each objective can best be taught in accordance with your own methods and experience.

The objective sheet may be also used as a quick pretest to determine prior knowledge of students and to determine whether further study or activities are necessary. Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and department. When changes in objectives are made, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

Suggested Activities (pink pages)

This component is included only in teacher material. The suggested activities page assists teachers during the preparation stage of the teaching/learning process by providing suggestions for delivery and/or presentation during the instructional process. Read the suggested activities before teaching the units so that supplemental materials can be obtained, audiovisual materials prepared, and outside resources contacted. Duties of the teacher will vary according to the particular unit.

The references that are listed are ones used in the development of each unit. They should be used by the teacher to supplement knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

Information Sheet (green pages)

The information sheet provides "must know" content essential for meeting the cognitive (knowledge level) objectives of the unit. The information is written in a topical outline form and is keyed to the specific objectives.

Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. The information sheet may also be used for coordination activities and advisory committees.

Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide motivation for each unit.

Transparency Masters (white pages in teacher material and green in student material)

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information, or they may reinforce information presented in the information sheet. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class' attention to the topic of discussion.

Assignment Sheet (brown pages)

Assignment sheets give students a chance at problem solving, self-assessment, and/or practical experience with the information. They assist students in the application of knowledges that are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided, when appropriate, and can be used by the student and/or teacher for checking student progress.

Job Sheets (blue pages)

Job sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure needed to complete each task or job. Diagrams, photographs, and illustrations are provided to assist students in achieving the skill.

A teacher should demonstrate to students the procedures outlined in each job sheet. Furthermore, the teacher needs to localize the job sheet according to the equipment and supplies available in the local situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Test (yellow pages)

This component provides criterion-referenced evaluation of every objective listed in the unit of instruction. It is crucial to note that both paper/pencil and performance objectives must be evaluated.

The tests may be written or oral. It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of questions from the units covered may be used for final tests at the end of each term if desired. If objectives have been added, deleted, or modified, be sure to make the changes on the test.

The acceptable response on a unit test--eighty-five percent in most units--may be raised or lowered to fit the topic or students' ability levels. The percentage applies to the overall score, not to each question. The final unit grade should be obtained by using the paper/pencil score along with teacher evaluations of student demonstrations of the desired skills.

Answers to Test and Assignment Sheets (pink pages)

These components are designed to assist the teacher in evaluation of student performances.

Page Numbering

Each publication from the Curriculum and Instructional Materials Center is assigned a specific abbreviation. For example, *Highway Maintenance Equipment Operator: Basic Core* has been abbreviated DOT I. The units are then numbered consecutively within each section. An example of a page number is DOT I - 1. Because CIMC publications are loose leaf, this system of page numbering was adopted so that pages from different manuals would not get mixed up.

Method of Disseminating Material

Material may be given out a unit or page at a time to keep the material before the student always new. Some teachers ask students to furnish a three-ring binder for the current unit of study. This is more convenient for taking the material home to study. Upon completion, each unit is then placed in a larger binder. The large binders may be purchased at cost from the CIMC. Some teachers have stored the materials by units in filing cabinets or boxes until needed. All the units may be given out at once if desired.

Student materials should be provided for each student for best results. Student materials contain everything but the test answers, answers to assignment sheets, and suggested activities. The tests are collated at the back of student material and should be removed and stored until needed. Students should be allowed to take their materials home at the end of the year.

Teaching Methods

It is a challenge to keep students motivated. Supplement the objectives by providing the "why," personal experiences, and current information. Prepare for each unit by deciding how each objective can best be taught. Allow students to become involved in preparing and planning.

ORIENTATION
UNIT I

UNIT OBJECTIVE

After completing this unit, the student should be able to list work requirements and equipment for highway maintenance and list potential hazards. This knowledge will be shown by completing the assignment sheet and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with highway maintenance orientation to their correct definitions.
2. State types of work performed by equipment operators.
3. Select from a list basic information needed for an equipment operator.
4. Select from a list basic skills needed by an equipment operator.
5. Select from a list personal characteristics of a good equipment operator.
6. Select from a list major skills and knowledge involved in an equipment operator's program.
7. Distinguish between advantages and disadvantages of being an equipment operator.
8. Match basic types of equipment to their correct uses.
9. Select from a list types of materials used in highway maintenance.
10. List reasons for keeping accurate records.
11. Select from a list types of records.
12. Select from a list methods for keeping accurate records.
13. Discuss personal goals as a highway maintenance equipment operator.

ORIENTATION
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities

   A. Order materials to supplement unit.

      1. Film--*You and What You Do.* Color, 16mm, 10 minutes, National Safety Council, code number 126-78-4-1. Available from the National Safety Council, 444 Michigan Avenue, Chicago, Illinois 60611.

         (NOTE: This film deals with danger involved when people are not trained in their jobs or do not understand instructions. It shows how important good communication between employer and employee can be. This film is available to Oklahoma teachers *only* from the Department of Transportation, 200 Northeast 21st, Oklahoma City, Oklahoma 73105. Out-of-state teachers must order from the address in Chicago.)

      2. Job descriptions for equipment operators, available from your state department of transportation.

   B. Make transparencies.

      (NOTE: Transparency masters in this unit have sample forms for maintenance, deficiency inspection records, and for materials requisition. The instructor may want to obtain forms used by his or her own state department of transportation and make transparency masters from those.)

   C. Provide students with objective sheet.

   D. Provide students with information and assignment sheets.

   E. Discuss unit and specific objectives.

   F. Discuss information and assignment sheets.

   G. Invite resource person to speak on highway maintenance.

   H. Arrange for a field trip to a maintenance yard to see the shop, the equipment, and to talk with operators and supervisors.

   I. Arrange for a field trip to observe a maintenance crew in operation.

   J. Encourage students to look for and identify equipment at construction and maintenance sites.

   K. Give test.

SUGGESTED ACTIVITIES

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM #1--Maintenance Report Form

      2. TM #2--Job or Operations Report Form

      3. TM #3--Deficiency or Inspection Report Form

      4. TM #4--Materials Requisition Form

      5. TM #5--Materials Requisition Form (Continued)

   E. Assignment Sheet #1--Discuss Personal Goals as a Highway Maintenance Equipment Operator

   F. Answers to assignment sheet

   G Test

   H. Answers to test

III. Unit reference--*Occupational Outlook Handbook*, n.a. Washington, D.C.: U.S. Department of Labor, Bureau of Labor Statistics, Bulletin No. 1650, 1970.

ORIENTATION
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Equipment operator--Person who operates equipment

   B. Highway maintenance--Repair and upkeep of roadway surfaces, structures, and rights-of-way

   C. Equipment maintenance--Care of equipment

   D. Skills--Abilities gained by experience

   E. Compacting--Pressing material together to increase density and stability

   F. Recycling--Reusing materials that would otherwise be unused

   G. Rigging--Setting up block and tackle to a winch, and stacking and hoisting material and equipment

   H. Pneumatic--Air-powered

   I. Hydraulic--Fluid-powered

II. Types of work performed by equipment operators

(NOTE: A type of work not listed below, but part of every operator's job, is public relations. The public sees the operator as a representative of the highway department. This is a serious responsibility for every employee.)

   A. Operating equipment used in highway maintenance operations

   (NOTE: Advancement as an operator means learning and operating heavier and larger equipment in increasingly difficult maintenance operations.)

   EXAMPLES:
   1. Dump trucks
   2. Trucks with accessories
   3. Loaders, tractors, and mowers
   4. Dozers, graders, and rollers
   5. Backhoes and cranes
   6. Paint machines, spraying equipment, and oil distributors
   7. Concrete pumps, drilling equipment, and jackhammers
   8. Snow and ice control equipment
   9. Asphalt mixing and laying equipment
   10. Hand tools--Shovels, picks, chain saws, posthole diggers

INFORMATION SHEET

- B. Performing snow and ice control operations
- C. Maintaining road surfaces

  EXAMPLES: Patching potholes and cracks (surface failures), raising depressed concrete, resurfacing asphalt, painting stripes, sweeping highways, inspecting, repairing and painting bridges

- D. Maintaining highway right-of-way

  EXAMPLES: Mowing shoulders and medians; weed control; placing and maintaining guard rails, signs, and fences, grading and stabilizing shoulders

- E. Loading, lashing, and unloading equipment and materials
- F. Performing minor maintenance and repair work on equipment
- G. Transporting equipment over public highways
- H. Maintaining and submitting records or reports related to manpower, materials, and equipment resources as directed
- I. Performing related work as required

III. Basic information needed for an equipment operator (Assignment Sheet #1)

- A. Know traffic regulations and safety practices for trucks and equipment
- B. Know principles of equipment operation well enough to detect defective operation
- C. Know agency operational and safety procedures

IV. Basic skills needed by an equipment operator (Assignment Sheet #1)

- A. Operating hand tools, construction and maintenance equipment
- B. Making minor running repairs and performing preventive maintenance on equipment
- C. Performing manual labor related to the operation of equipment

  EXAMPLES: Loading, lashing, unloading, rigging, shoveling, raking, lifting, and carrying

- D. Establishing and maintaining effective working relationships with employees and the public
- E. Maintaining records and preparing basic reports
- F. Understanding and following oral instructions and written diagrams

INFORMATION SHEET

V. Personal characteristics of a good equipment operator

(NOTE: It is impossible to cover every phase of safety and hazardous conditions; therefore, knowledge and adaptation to basic rules will help the equipment operator develop good and safe habits.)

A. Checks all equipment before starting work

B. Operates all equipment correctly

C. Is safety conscious and follows safety regulations

(NOTE: In any 40-minute working period, one worker in the United States will be killed in an on-the-job accident, more than 160 workers will suffer disabling injuries, and several million dollars will be spent or lost as a result. A significant majority of these accidents occur to workers during their first six months on the job.)

D. Takes instructions readily and follows company rules

E. Practices conservation of materials and equipment

F. Displays enthusiasm about job

G. Exhibits pride in the trade

H. Controls temper at all times

I. Is punctual

J. Is a good citizen

K. Is cooperative

VI. Major skills and knowledge involved in an equipment operator's program

A. Measuring

B. Math

C. Fuels, lubricants, and coolants

D. Rigging

E. Equipment maintenance

F. Equipment operation

INFORMATION SHEET

VII. Advantages and disadvantages of being an equipment operator

A. Advantages

1. Good pay
2. Outdoor work
3. Job variety
4. Opportunity to improve skills

   EXAMPLE: Operating different types of equipment

5. Job mobility

   (NOTE: An operator with several skills has opportunity to work in other geographic locations.)

6. Comfortable dress

   (NOTE: Operators wear comfortable work clothes and do not have to wear dress clothes.)

7. Sense of accomplishment

   (NOTE: You can see the results of your work at the end of each day.)

B. Disadvantages

1. Work may be dirty
2. Work may be hazardous

   EXAMPLES:
   1. Dangerous areas--Blasting, steep slopes and swamps
   2. Dangerous to health--Back injuries and hemorrhoids, hearing and lung diseases
   3. Dangerous work--Possibility of accidents

3. Exposure to weather conditions

   EXAMPLE: Hot weather in summer and cold weather in winter

4. Safety equipment may be uncomfortable to wear

   EXAMPLES: Safety glasses, dust respirators, earplugs, headphones, safety shoes, and hard hats

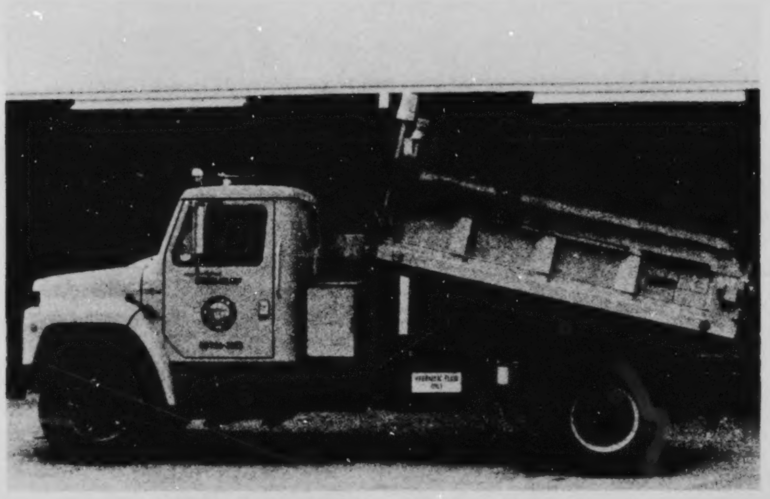
5. Work may require travel away from home

INFORMATION SHEET

VIII. Basic types of equipment and their uses

A. Dump truck--Used for hauling materials and towing; has attachments for snow removal (Figure 1)

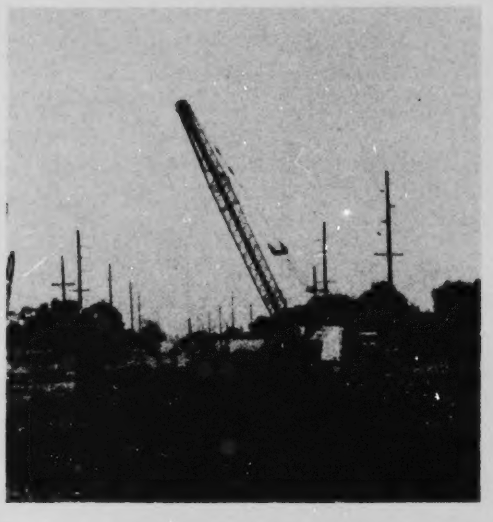
FIGURE 1



Used with permission of The Heil Company.

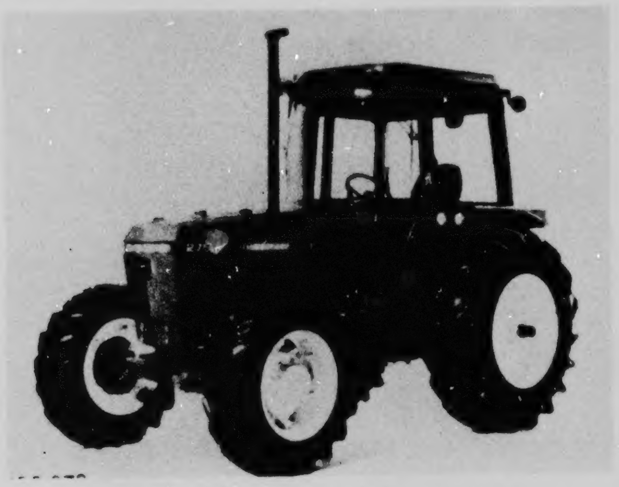
B. Cable crane--Used for lifting, clearing ditches, and picking up soil and aggregate (Figure 2)

FIGURE 2



C. Tractor--Used to tow or power other equipment for a variety of maintenance operations (Figure 3)

FIGURE 3

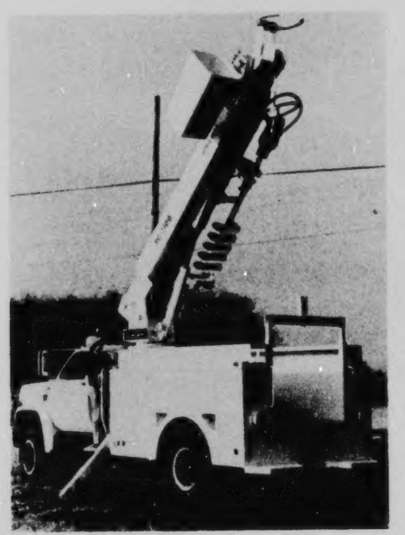


Courtesy of Deere & Company, Moline, Illinois.

D. Cherry picker (high lift)--Used for precision lifting and posthole digging (Figure 4)

(NOTE: Cherry pickers are favored by maintenance and utility companies because they can put the workers where they need to be.)

FIGURE 4

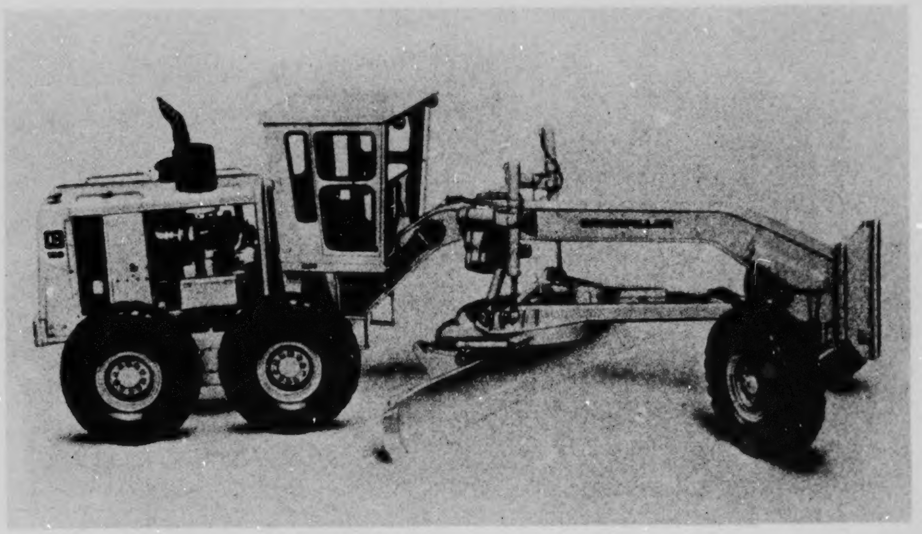


Courtesy of Pitman Division of A.B. Chance Company, subsidiary of Emerson Electric Company.

INFORMATION SHEET

E. Grader--Used for shaping and maintaining roads, snow removal, fine grading, and asphaltic materials work (Figure 5)

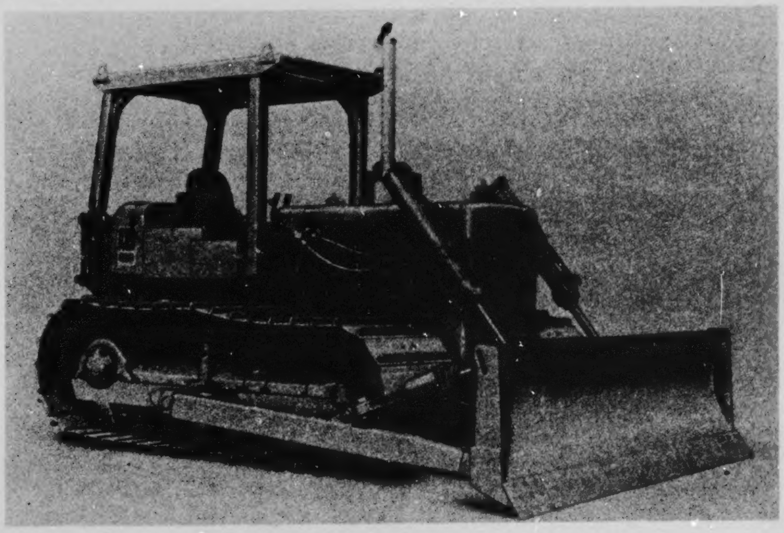
FIGURE 5



Courtesy of Caterpillar Tractor Company.

F. Dozer--Used for rough work; to move soil, cut banks, and dig pits (Figure 6)

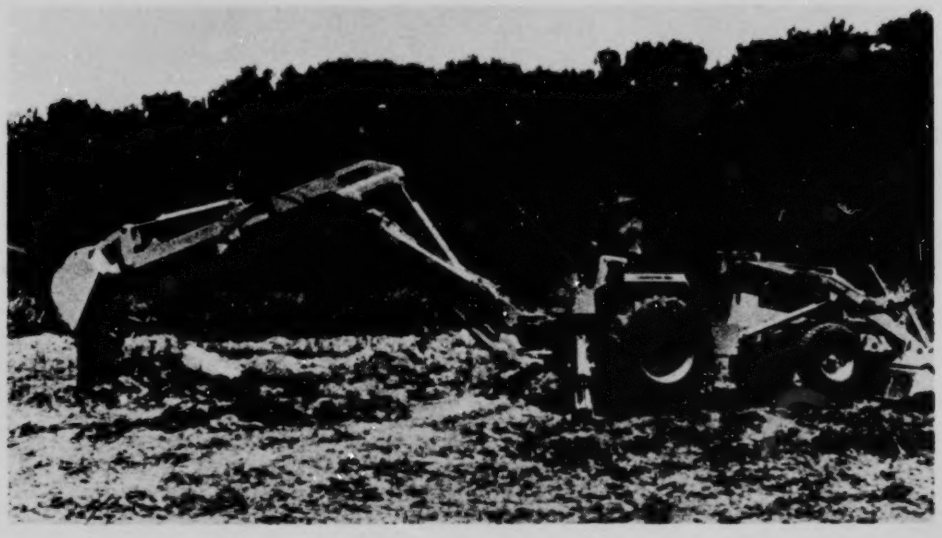
FIGURE 6



Courtesy of Caterpillar Tractor Company.

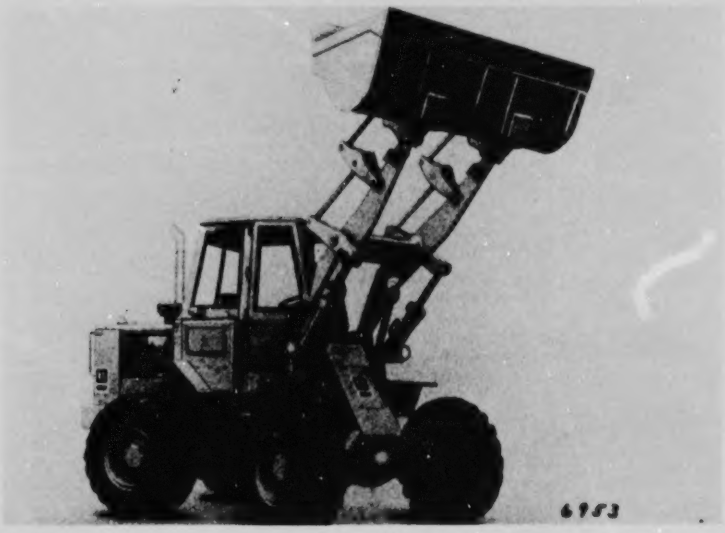
G. Backhoe--Used for filling, backfilling, excavating, trenching, tree removal, and loading (Figure 7)

FIGURE 7



H. Front-end loader--Used for production loading of trucks and hoppers (Figure 8)

FIGURE 8

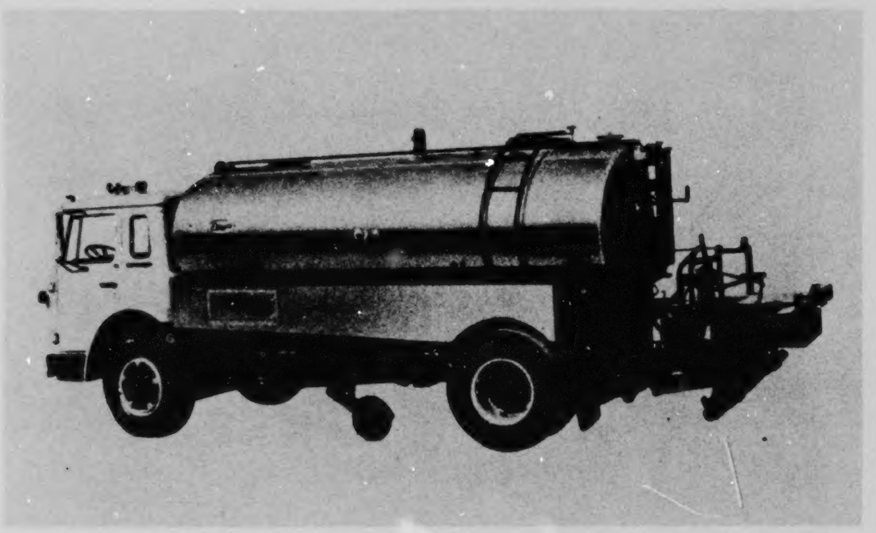


Courtesy of Caterpillar Tractor Company.

INFORMATION SHEET

I. Asphalt distributor--Used to apply liquid asphalt (Figure 9)

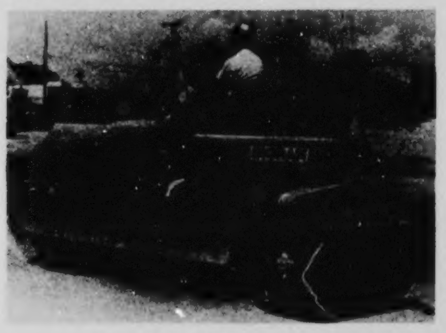
FIGURE 9



Courtesy of E.D. Etnyre and Company.

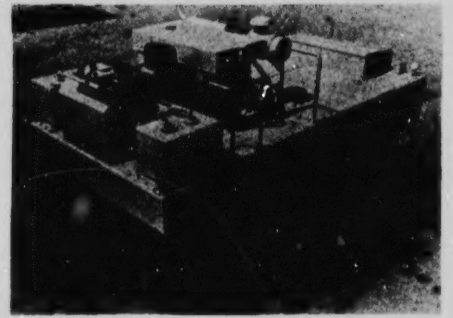
J. Roller--Used to compact materials (Figures 10 and 11)

FIGURE 10



PNEUMATIC ROLLER

FIGURE 11



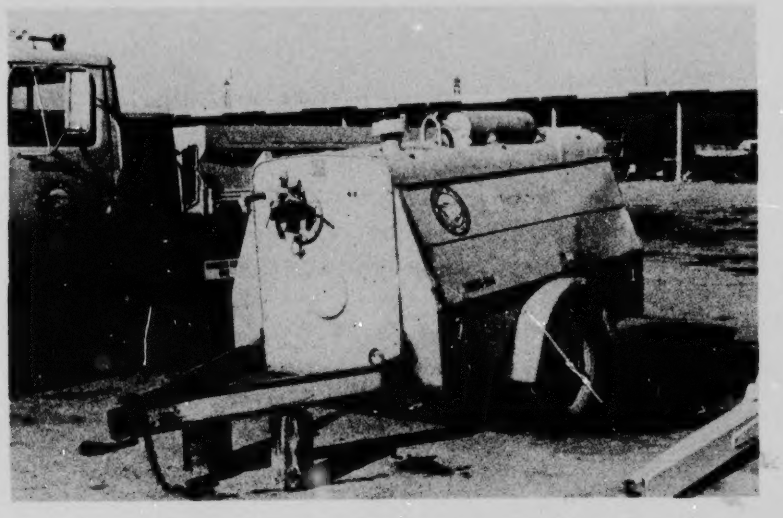
Courtesy of Ingram Manufacturing Company.

STEEL WHEEL ROLLER

INFORMATION SHEET

K. Air compressor--Used to compress air to operate other pieces of equipment (Figure 12)

FIGURE 12



IX. Types of materials used in highway maintenance

A. Asphalt-petroleum based materials

EXAMPLES: Crushed asphalt mixes, hot and cold mix materials, emulsions (water and asphaltic materials), liquid asphalt

B. Portland cement concrete

C. Aggregate

EXAMPLES: Rock, crushed rock, gravel, and other solid particle materials

D. Herbicides

E. Rapid-setting patching materials

F. Soil materials

EXAMPLES: Sand, dirt

G. Salt

(NOTE: Some areas use cinders and chemical compounds mixed with salt for ice control.)

INFORMATION SHEET

X. Reasons for keeping accurate records

   A. Accurate record keeping is a *requirement* of your job

   B. Ensures that equipment maintenance is performed on schedule

   C. Keeps supervisor and administration informed of transactions

   D. Aids in keeping equipment safe to operate

   E. Provides a history for the vehicle or equipment when a different operator uses that equipment

XI. Types of records (Transparencies #1-#5)

(NOTE: These are general examples. Each agency will have its own record keeping requirements and codes.)

   A. Daily maintenance

   B. Daily mileage

   C. Shop maintenance requests

   D. Monthly reports

   E. Job or operations reports

   F. Deficiency reports

   G. Materials requisitions

XII. Methods for keeping accurate records

   A. Keep record books and a pen or pencil in the vehicle at all times

   B. Complete daily inspection reports as you perform the inspection; do not wait until later

   C. Know the service intervals as stated in your departmental preventive maintenance program

   (NOTE: Equipment operated in adverse conditions such as dust or extreme cold should be serviced at more frequent intervals.)

   D. Write down hours of operation or mileage and the maintenance or operation performed

INFORMATION SHEET

E. Provide *all* information required

F. Initial or sign the form

G. Where appropriate, be sure colored copies go to the proper parties

H. Turn in records and reports on time

Maintenance Report Form

Date	Mileage Or Hourmeter Reading	Oil Added Only (Qts.)	Oil Changed (Quarts)	Sae Oil Grade	Oil Filter Changed	Grease Job	Air Cleaner Serviced	Tune Up	P. M. Inspection	Annual Inspection	Pack Front Wheel Brgs.	Pack Rear Wheel Brgs.	Winterize			Performed By

Used with permission of the Oklahoma Department of Transportation

Job or Operations Report Form

DATE ______________________

District	Area	ROUTE		PROJECT ID					Type	Work	Miles or Hours	Signature
		No.	County	Class Juris.	Number Number	Sec.	Agr. Stage	Func. Unit	Act.	Task		

TM #2

Used with permission of the Oklahoma Department of Transportation

DOT I-19

Deficiency or Inspection Report Form

OPERATOR'S DEFICIENCY REPORT

SHC NO. ______________ Mileage or hours ______________

AFTER OPERATION CHECK ITEMS NEEDING ATTENTION BY "X"

ENGINE
- ______ Knocks
- ______ No Power
- ______ Noisy
- ______ Leaks Oil
- ______ Oil Pressure

CLUTCH
- ______ Slips
- ______ Grabs
- ______ Chatters
- ______ Free Travel

TRANSMISSION
- ______ Noisy
- ______ Disengages
- ______ Leaks Oil

REAR AXLE
- ______ Noisy
- ______ Leaks Oil

DRAIN AIR TANKS

HOIST
- ______ Won't Lift
- ______ Settles
- ______ Leaks Oil
- ______ Flips Over

STEERING
- ______ Wanders
- ______ Shimmy
- ______ Hard
- ______ Free Play

BRAKES
- ______ Grab
- ______ Squeal
- ______ Air Pressure
- ______ Insufficient
- ______ Don't Release
- ______ Pedal Travel
- ______ Fluid

ELECTRICAL
- ______ Lights
- ______ Horn
- ______ Battery
- ______ Charging System
- ______ Starter
- ______ Wiring

SPRINGS
- ______ Broken
- ______ Shifted

FUEL
- ______ Pump
- ______ Lines
- ______ Carburetor

EXHAUST
- ______ Leaks
- ______ Muffler
- ______ Tail Pipe

COOLING SYSTEM
- ______ Leaks
- ______ Overheats

EMERGENCY EQUIPMENT
- ______ Reflectors
- ______ Fuses
- ______ Flares
- ______ Fire Ext.
- ______ First Aid Kit
- ______ Tire Chains

GENERAL
- ______ Wheels
- ______ Hubs
- ______ Tires
- ______ Cab
- ______ Body
- ______ Radio
- ______ Windshield Swipes

Explain items needing attention ______________________________

____

____

____

Signed ______________________________ Date ______________
Driver

Completed ______________ 19 ______ ______________________
Shop Foreman

TM #3

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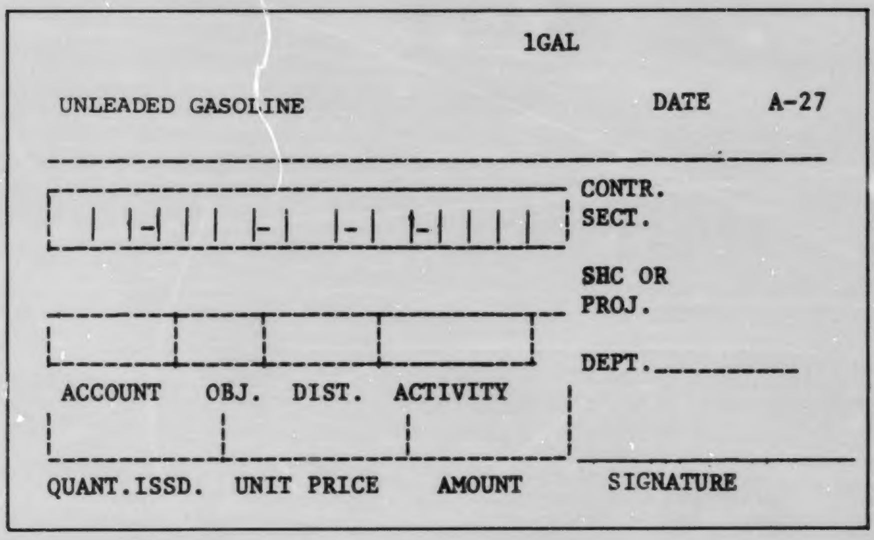
DOT I-21

Materials Requisition Form



1GAL

UNLEADED GASOLINE

DATE A-27

CONTR.
SECT.

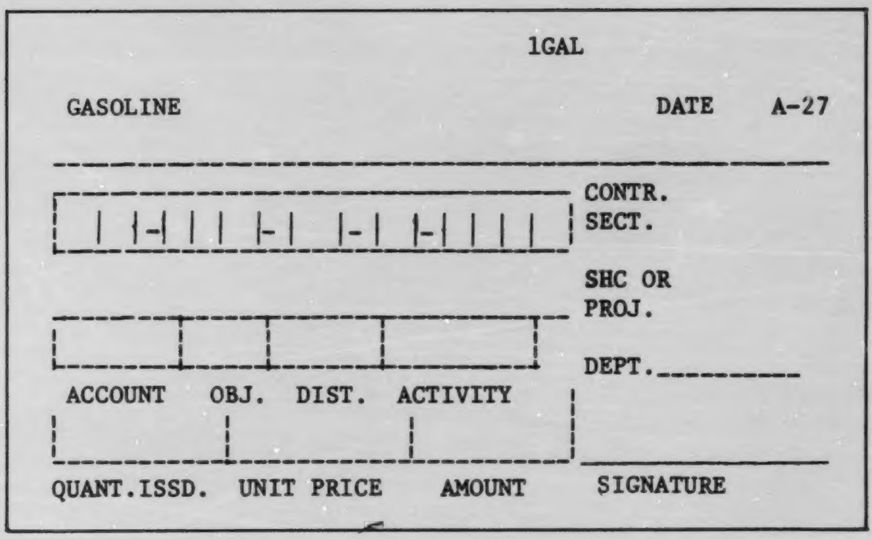
SHC OR
PROJ.

DEPT.__________

ACCOUNT OBJ. DIST. ACTIVITY

QUANT.ISSD. UNIT PRICE AMOUNT

SIGNATURE



1GAL

GASOLINE

DATE A-27

CONTR.
SECT.

SHC OR
PROJ.

DEPT.__________

ACCOUNT OBJ. DIST. ACTIVITY

QUANT.ISSD. UNIT PRICE AMOUNT

SIGNATURE

Used with permission of the Oklahoma Department of Transportation

Materials Requisition Form

(Continued)

Note copy distribution instructions

WHITE - Division Accountant's Copy
YELLOW - Deliver with Material
PINK - Give with Purchase

DEPARTMENT OF TRANSPORTATION

DISTRIBUTION ACCT. NO.__________

WAREHOUSE REQUISITION AND TRANSFER **C №**

ISSUING WAREHOUSE__________ DIVISION NO.______ DATE__________, 19___

CHARGE TO

MAINTENANCE SECTION	DIST.	PROJECT NO.	S.H.C. EQUIPMENT NO.	DEPARTMENT

QTY. REQ.	QTY. DEL'D	DESCRIPTION OF MATERIAL	Object Code ↓	UNIT PRICE	AMOUNT

ISSUED BY:

IF MATERIAL IS CHARGED TO A MAINTENANCE SECTION FULL EXPLANATION OF USE OF MATERIAL MUST BE WRITTEN ON THE FACE OF THIS TRANSFER.

Total______

REQUESTED BY__________

APPROVED BY__________ REC'D BY__________

D T FORM NO A-27 REV 4-15-81

TM #5

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DOT I - 25

ORIENTATION
UNIT I

ASSIGNMENT SHEET #1--DISCUSS PERSONAL GOALS AS A HIGHWAY MAINTENANCE EQUIPMENT OPERATOR

NAME ________________________________ SCORE ______________

When you signed on for training and employment as an equipment operator in highway maintenance, you probably did not have a clear idea about the work you would be doing. Now that you have read this unit and discussed it in class, you are better prepared for the job you have undertaken. You have a better understanding of what is expected of you. In this assignment sheet you will be asking yourself what *you* expect from the job--what you have to offer and what you can accomplish as an equipment operator. Keep these objectives in mind as you continue your training. It is easier to meet your goals if they are well defined.

Answer the following questions about your objectives as a highway maintenance equipment operator, and then discuss with class.

A. What was your attitude toward this program when you first applied for it?

____

____

____

____

B. How has this unit encouraged you to proceed? ____________________

____

____

____

C. What three things about equipment operation are most attractive to you?

1. ____

____

2. ____

____

3. ____

____

ASSIGNMENT SHEET #1

D. What three things about equipment operation are least attractive to you?

1. ______________________________
____
2. ______________________________
____
3. ______________________________
____

E. Do you have career goals as an equipment operator? Yes _____ No _____
If you checked "yes," what are they?

____
____
____
____

F. Do you have personal goals as an equipment operator? Yes _____ No _____
If you checked "yes," what are they?

____
____
____
____

G. Which pieces of equipment interest you most? List three pieces of equipment in order of preference, and tell why you chose them.

1. ______________________________
____
2. ______________________________
____
3. ______________________________
____

ASSIGNMENT SHEET #1

H. What skills and knowledge do you bring with you that will help you in your work and study?

____

____

____

____

I. Which personality or character traits that you have will be useful assets to you in your job?

EXAMPLES: Hard worker, like people, like machines, good with hands

1. ____________________________________
2. ____________________________________
3. ____________________________________
4. ____________________________________
5. ____________________________________

J. What handicaps or problem areas do you foresee? What can you do to neutralize or overcome them in a job situation?

EXAMPLES: Do not like to work alone, fear of large machines, shy around other people or people in authority

____

____

____

____

____

____

____

ASSIGNMENT SHEET #1

K. Rate yourself on the following items as good, fair, or poor.

	Good	Fair	Poor
1. Safety conscious	____	____	____
2. Driving ability	____	____	____
3. Health	____	____	____
4. Neatness	____	____	____
5. Physical coordination	____	____	____
6. Ability to get along with people	____	____	____
7. Ability to work with machines	____	____	____
8. Ability to follow instructions	____	____	____
9. Desire to do a good job	____	____	____
10. Willingness to read and study	____	____	____
11. Willingness to learn new skills	____	____	____
12. Ability to present a friendly, cooperative attitude to the public as a representative of the highway maintenance team	____	____	____

ORIENTATION
UNIT I

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1--Evaluated to the satisfaction of the instructor

(NOTE: If answers to E and F are "No," you may wish to talk privately with the student to guide the student in developing career and personal goals. Also, encourage students to discuss their expectations and concerns about training and work.)

ORIENTATION
UNIT I

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with highway maintenance orientation to their correct definitions. Write the correct numbers in the blanks.

_____a. Reusing materials that would otherwise be unused

_____b. Care of equipment

_____c. Setting up block and tackle to a winch, and stacking and hoisting material and equipment

_____d. Abilities gained by experience

_____e. Air-powered

_____f. Person who operates equipment

_____g. Pressing material together to increase density and stability

_____h. Fluid-powered

_____i. Repair and upkeep of roadway surfaces, structures, and rights-of-way

1. Recycling
2. Hydraulic
3. Equipment operator
4. Equipment maintenance
5. Compacting
6. Highway maintenance
7. Pneumatic
8. Skills
9. Rigging

2. State five types of work performed by equipment operators.

a. ____

b. ____

c. ____

d. ____

e. ____

3. Select from the following list basic information needed for an equipment operator. Write an "X" in the blank before each correct answer.

_____a. Know traffic regulations and safety practices for trucks and equipment

_____b. Know work hours, break schedules, and holidays

_____c. Know agency operational and safety procedures

TEST

_____d. Know people in administrative positions in the agency

_____e. Know how to win friends and influence people

_____f. Know penalties for failure to follow recommended procedures

_____g. Know principles of equipment operation well enough to detect defective operation

4. Select from the following list basic skills needed by an equipment operator. Write an "X" in the blank before each correct answer.

_____a. Having exceptional physical coordination

_____b. Maintaining records and preparing basic reports

_____c. Developing good writing skills

_____d. Performing manual labor related to the operation of equipment

_____e. Understanding and following oral instructions and written diagrams

_____f. Coordinating purchasing and delivery schedules

_____g. Operating hand tools, construction and maintenance equipment

_____h. Making minor running repairs and performing preventive maintenance on equipment

_____i. Making public speeches

_____j. Establishing and maintaining effective working relationships with employees and the public

5. Select from the following list personal characteristics of a good equipment operator. Write an "X" in the blank before each correct answer.

_____a. Is punctual

_____b. Practices conservation of materials and equipment

_____c. Operates equipment at excessive speeds

_____d. Exhibits pride in the trade

_____e. Controls temper at all times

_____f. Displays enthusiasm about job

_____g. Takes regular breaks at his or her convenience

_____h. Is safety conscious and follows safety regulations

TEST

_____i. Puts personal gear where it is convenient

_____j. Checks all equipment before starting work

_____k. Operates all equipment correctly

_____l. Takes instructions readily and follows company rules

_____m. Expresses that he or she is in total charge of assigned operations

_____n. Is a good citizen

_____o. Is cooperative

6. Select from the following list major skills and knowledge involved in an equipment operator's program. Write an "X" in the blank before each correct answer.

_____a. Equipment maintenance

_____b. Equipment repair

_____c. Equipment operation

_____d. Body work

_____e. Rigging

_____f. Accounting

_____g. Fuels, lubricants, and coolants

_____h. Equipment brands and models

_____i. Highway design

_____j. Math

_____k. Measuring

7. Distinguish between advantages and disadvantages of being an equipment operator. Write an "A" before advantages and a "D" before disadvantages in the blanks.

_____a. Work may be hazardous

_____b. Job variety

_____c. Good pay

_____d. Comfortable dress

_____e. Outdoor work

_____f. Exposure to weather conditions

_____g. Opportunity to improve skills

TEST

_____h. Safety equipment may be uncomfortable to wear

_____i. Job mobility

_____j. Work may require travel away from home

_____k. Sense of accomplishment

8. Match basic types of equipment to their correct uses. Write the correct numbers in the blanks.

_____a. Used for hauling materials and towing; has attachments for snow removal

_____b. Used for lifting, clearing ditches, and picking up soil and aggregate

_____c. Used to tow and power other equipment for variety of maintenance operations

_____d. Used for precision lifting and posthole digging

_____e. Used for shaping and maintaining roads, snow removal, fine grading, and asphaltic materials work

_____f. Used for rough work; to move soil, cut banks, and dig pits

_____g. Used for filling, backfilling, excavating, trenching, tree removal, and loading

_____h. Used for production loading of trucks and hoppers

_____i. Used to apply liquid asphalt

_____j. Used to compact materials

_____k. Used to compress air to operate other pieces of equipment

1. Dozer
2. Front-end loader
3. Roller
4. Dump truck
5. Backhoe
6. Grader
7. Cable crane
8. Air compressor
9. Tractor
10. Cherry picker (high lift)
11. Asphalt distributor

9. Select from the following list types of materials used in highway maintenance. Write an "X" in the blank before each correct answer.

_____a. Washington cement concrete

_____b. Portland cement concrete

_____c. Soil materials

_____d. Plastics materials

TEST

_____e. Rapid-setting patching materials

_____f. Salt

_____g. Pesticides

_____h. Aggregate

_____i. Asphalt-petroleum based materials

_____j. Herbicides

_____k. Organic plant materials

10. List four reasons for keeping accurate records.

a. ____

b. ____

c. ____

d. ____

11. Select from the following list types of records. Write an "X" in the blank before each correct answer.

_____a. Time on breaks

_____b. Monthly reports

_____c. Maintenance performed under warranty

_____d. Daily maintenance

_____e. Materials requisitions

_____f. Annual leave requisitions

_____g. Shop maintenance requests

_____h. Personnel reports

_____i. Job or operations reports

_____j. Efficiency reports

_____k. Deficiency reports

_____l. Downtime reports

_____m. Daily mileage

TEST

12. Select from the following list methods for keeping accurate records. Write an "X" in the blank before each correct answer.

_____a. Complete daily inspection reports at the end of the work day

_____b. Write down hours of operation or mileage and the maintenance or operation performed

_____c. Initial or sign the form

_____d. Have other operators keep forms for your equipment

_____e. Provide *all* information required

_____f. Turn records and reports in when convenient

_____g. Turn in records and reports on time

_____h. Know the service intervals as stated in your departmental preventive maintenance program

_____i. Keep record books and a pen or pencil in the vehicle at all times

_____j. Complete daily inspection reports as you perform the inspection; do not wait until later

_____k. Leave details of record keeping to your supervisor

_____l. Where appropriate, be sure colored codes go to the proper parties

_____m. Keep photocopies of all reports and records

(NOTE: Test question 13 is an assignment sheet. It is an important part of this test. If it has not been completed, check with your instructor.)

13. Discuss personal goals as a highway maintenance equipment operator.

ORIENTATION
UNIT I

ANSWERS TO TEST

1. a. 1
   b. 4
   c. 9
   d. 8
   e. 7
   f. 3
   g. 5
   h. 2
   i. 6

2. Answer should include any five of the following
   a. Operating equipment used in highway maintenance operations
   b. Performing snow and ice control operations
   c. Maintaining road surfaces
   d. Maintaining highway right-of-way
   e. Loading, lashing, and unloading equipment and materials
   f. Performing minor maintenance and repair work on equipment
   g. Transporting equipment over public highways
   h. Maintaining and submitting records or reports related to manpower, materials, and equipment resources as directed
   i. Performing related work as required

3. a, c, g

4. b, d, e, g, h, j

5. a, b, d, e, f, h, j, k, l, n, o

6. a, c, e, g, j, k

7. a. D
   b. A
   c. A
   d. A
   e. A
   f. D
   g. A
   h. D
   i. A
   j. D
   k. A

ANSWERS TO TEST

8. a. 4
   b. 7
   c. 9
   d. 10
   e. 6
   f. 1
   g. 5
   h. 2
   i. 11
   j. 3
   k. 8

9. b, c, e, f, h, i, j

10. Answer should include any four of the following

    a. Accurate record keeping is a *requirement* of your job

    b. Ensures that all equipment maintenance is performed on schedule

    c. Keeps supervisor and administration informed of transactions

    d. Aids in keeping equipment safe to operate

    e. Provides a history for the vehicle or equipment when a different operator uses that equipment

11. b, d, e, g, i, k, m,

12. b, c, e, g, h, i, j, l

13. Evaluated to the satisfaction of the instructor

SAFETY
UNIT II

UNIT OBJECTIVE

After completing this unit, the student should be able to practice both personal and general job safety while performing duties, as well as know appropriate flagging procedures on public throughways. This knowledge will be shown by completing assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with safety to their correct definitions.
2. State reasons for practicing job safety.
3. Match colors of safety color code to their correct applications.
4. Select from a list rules for general job safety.
5. Select from a list procedures used to maintain a clean and orderly work area.
6. State personal safety rules.
7. Arrange in order procedures used to lift heavy objects correctly.
8. Select from a list measures for the prevention of injuries from extreme cold.
9. Select from a list proper clothing for extreme cold.
10. Select from a list symptoms of cold exposure.
11. Arrange in order procedures for treatment of cold exposure.
12. Select from a list symptoms of frostbite.
13. Select from a list treatments for frostbite.
14. State measures to take for prevention of heat stroke, heat cramps, and heat exhaustion.
15. Write critical information about symptoms and treatment of heat stroke, heat cramps, and heat exhaustion.

OBJECTIVE SHEET

16. Select from a list procedures for treating bee stings.
17. Select true statements about procedures for treating severe reactions to bee stings.
18. Select from a list components of the fire triangle.
19. Match classes of fires to their correct descriptions.
20. Match types of fire extinguishers to classes of fires for which each is used.
21. State safety rules concerning flammable liquids.
22. State safety rules for traveling equipment on public roads.
23. Select from a list signal procedures for a breakdown.
24. Select from a list rules for personal job site safety.
25. Select from a list procedures for traveling equipment on the job site.
26. Select from a list factors affecting traffic controls for maintenance operations.
27. Select from a list rules for use of traffic control devices.
28. Select from a list rules for proper placement of signs.
29. Match channeling devices to their proper uses.
30. State responsibilities of flag person.
31. Identify flagging positions.
32. State correct safety rules for flag persons.
33. Compile a survey of winter clothing needs.
34. Distinguish among symptoms and treatments for heat stroke, heat cramps, and heat exhaustion.
35. Analyze accident case studies.
36. Locate correct placement for emergency signals in the event of breakdown.
37. Construct a diagram of appropriate traffic control for a two-lane roadway.
38. Distinguish between correct and incorrect procedures for flag persons.

OBJECTIVE SHEET

39. Demonstrate the ability to

    a. Show the correct way to lift.

    b. Treat frostbite.

    c. Give mouth-to-mouth resuscitation.

    d. Flag with a paddle.

    e. Flag with a flag.

    f. Flag with a flashlight.

SAFETY
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities

   A. Order materials planned to supplement unit.

      1. *A New Way to Lift.* Color, 10 minutes, Journal Films, Inc., 1971. Available from Journal Films, Inc., 930 Pitner Avenue, Evanston, Illinois 60202.

      2. *Danger Zone: Your Back.* Color, 19 minutes, VISUCOM Productions, 1981. Available from VISUCOM Productions, Box 5472, Redwood City, California 94063.

         (NOTE: Safety film demonstrates good lifting, pulling, and pushing practices to motivate employees to participate in accident prevention.)

      3. *Give Him Air.* Color, 18 minutes, International Film Bureau, 1981. Available from International Film Bureau, 332 South Michigan Avenue, Chicago, Illinois 60604.

         (NOTE: Film identifies five main causes of death due to loss of air, and then demonstrates the appropriate rescue techniques.)

      4. *Housekeeping Means Safekeeping.* Color, 10 minutes, Journal Films, Inc., 1975. Available from Journal Films, Inc., 930 Pitner Avenue, Evanston, Illinois 60202.

      5. *Night Safety at Work Site.* Color, 15 minutes, slide/cassette tape, American Traffic Services Association, n.d. Available from Oklahoma Department of Transportation, Training Division, 200 N.E. 21st Street, Oklahoma City, Oklahoma 73105.

         (NOTE: Program deals with the safety of maintenance and construction crews, and traffic control through night work areas.)

      6. *Shake Hands With Danger.* Color, 22 minutes, Calvin Productions, 1980. Available from Calvin Productions, 1105 Truman Road, Kansas City, Missouri 64106.

         (NOTE: Safety film stresses importance of safety procedures and the consequences that will result if ignored or overlooked. This is an excellent film to show equipment operators. This film is available on a free-loan basis to Oklahoma teachers *only*. Order from the Oklahoma State Department of Vocational and Technical Education/ Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074. Out-of-state teachers must order from the address listed.)

      7. *Stop a Fire Before It Starts.* Color, 10 minutes, Journal Films, Inc., 1975. Available from Journal Films, Inc., 930 Pitner Avenue, Evanston, Illinois 60202.

SUGGESTED ACTIVITIES

8. *The Flagman.* Color, 23 minutes, Utah State Department of Highways, n.d. Available from Oklahoma Department of Transportation, Training Division, 200 N.E. 21st Street, Oklahoma City, Oklahoma 73105.

   (NOTE: Film shows the flagman's requirements, duties, responsibilities, techniques, and how important his duties are.)

9. *The Industrial Weight Lifter.* Color, 11 minutes, International Film Bureau, 1965. Available from International Film Bureau Inc., 332 South Michigan Avenue, Chicago, Illinois 60604.

B. Make transparencies.

C. Provide students with objective sheet.

D. Provide students with information, assignment, and job sheets.

E. Discuss unit and specific objectives.

F. Discuss information and assignment sheets.

G. Demonstrate and discuss procedures outlined in job sheets.

H. Contact a safety engineer as a resource person for class concerning safety on the job.

I. Show color samples and conduct an oral drill on the colors and applications of the safety color code.

J. Arrange to visit a shop and have students observe and analyze safety equipment and procedures.

K. Have students operate a fire extinguisher.

L. Have students complete a first-aid course and earn certification according to OSHA regulations.

M. Demonstrate and discuss precaution and first-aid techniques for dangers in your area such as snake bites, scorpion stings, tornados.

N. Give test.

II. Instructional materials

A. Objective sheet

B. Suggested activities

C. Information sheet

SUGGESTED ACTIVITIES

D. Transparency masters

   1. TM #1--Correct Way to Lift Heavy Objects
   2. TM #2--Face and Skin Conditions in Heat Stroke and Heat Exhaustion
   3. TM #3--The Fire Triangle
   4. TM #4--Types of Fire Extinguishers
   5. TM #5--Safety Equipment to be Carried on All Vehicles
   6. TM #6--Emergency Signals to be Carried in All Vehicles
   7. TM #7--Examples of Portable and Temporary Mountings

E. Assignment sheets

   1. Assignment Sheet #1--Compile a Survey of Winter Clothing Needs
   2. Assignment Sheet #2--Distinguish Among Symptoms and Treatments for Heat Stroke, Heat Cramps, and Heat Exhaustion
   3. Assignment Sheet #3--Analyze Accident Case Studies
   4. Assignment Sheet #4--Locate Correct Placement for Emergency Signals in the Event of Breakdown
   5. Assignment Sheet #5--Construct a Diagram of Appropriate Traffic Control for a Two-Lane Roadway
   6. Assignment Sheet #6--Distinguish Between Correct and Incorrect Procedures for Flag Persons

F. Answers to assignment sheets

G. Job sheets

   1. Job Sheet #1--Show the Correct Way to Lift
   2. Job Sheet #2--Treat Frostbite
   3. Job Sheet #3--Give Mouth-to-Mouth Resuscitation
   4. Job Sheet #4--Flag with a Paddle
   5. Job Sheet #5--Flag with a Flag
   6. Job Sheet #6--Flag with a Flashlight

H. Test

I. Answers to test

SUGGESTED ACTIVITIES

III. Unit references

A. *Accident Prevention Manual for Industrial Operations,* 7th ed. National Safety Council, 444 North Michigan Avenue, Chicago, Illinois, 1974.

B. *First Aid.* Washington, D.C.: United States Department of Labor, Bureau of Mines, 1978.

C. Hendrix, Laborn J., "Bud." *Millwright Instructional Materials.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/ Curriculum and Instructional Materials Center and Associated General Contractors of America, 1980.

D. *Manual on Uniform Traffic Control Devices for Streets and Highways.* Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, 1971.

E. *Rubber-Tired Front End Loader and Forklift Truck Accident Prevention.* Mesa Instruction Guide 30. Washington, D.C.: United States Department of the Interior, Mining Enforcement and Safety Administration, 1975.

F. Smith, Earl. *Power Line Technician.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1978.

SAFETY
UNIT II

INFORMATION SHEET

I. Terms and definitions

  A. Safety--State or condition of being safe; freedom from danger, risk, or injury

  B. Accident--Any suddenly occurring, unintentional event which causes injury or property damage

  C. First aid--Immediate, temporary care given the victim of an accident or sudden illness until the services of a physican can be obtained

  D. Occupational Safety and Health Act (OSHA)--Federal legislation designed to ensure safe and sanitary working conditions for employees

  E. Frostbite--Tissue damage due to freezing of tissue fluids

  F. Heat stroke--Immediate, life-threatening emergency characterized by extremely high body temperature and disturbance of sweating mechanism

  G. Heat cramps--Muscular pains and spasms due to loss of salt through sweating or to inadequate intake of salt

  H. Heat exhaustion--Fatigue, weakness, and sometimes collapse due to loss of body fluids through sweating and inadequate water intake

  I. Resuscitation--Act of bringing one back to full consciousness

  J. Flammable--Capable of being easily ignited and burning with extreme rapidity

  K. Explosive--Something tending to explode

  L. Combustible--Capable of bursting into flames

  M. Extinguish--To cause to cease burning

  N. Pressurized--Stored under pressure greater than the pressure of the atmosphere

  O. Solvent--Liquid substance capable of dissolving or dispersing one or more other substances

  P. Spotter--Person who directs a machine operator into position

  Q. Channelize--To divert traffic flow from one lane into another lane

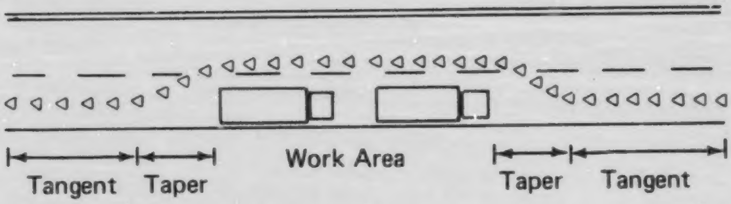
  R. Taper--Angle at which traffic is diverted from regular lane into new lane

INFORMATION SHEET

S. Tangent--Sections of signposted roadway preceding and following taper (Figure 1)

EXAMPLE:

FIGURE 1



II. Reasons for practicing job safety

A. Prevent physical harm to yourself and others

B. Avoid loss of work hours

C. Avoid possible loss of pay

D. Lower cost to employer

E. Prevent loss or damage of equipment or materials

F. Lower insurance rates

G. Prevent hardship on family

H. Provide regular job schedules

I. Prevent possible loss of job

III. Colors and applications of the safety color code

A. Federal safety red

1. Designates danger
2. Identifies fire protection equipment and its location
3. Identifies portable containers of flammable liquids
4. Identifies emergency stop bars, stop buttons, and emergency electrical stop switches on machinery

B. Federal safety yellow

1. Designates caution and marks physical hazards
2. Designates waste containers for explosive or combustible materials

INFORMATION SHEET

    3. Designates caution against starting, using, or moving equipment while under repair, or against the use of defective equipment
    4. Identifies the starting point or power source of machinery

  C. Federal safety orange

    1. Designates dangerous parts of equipment which may cut, crush, shock, or otherwise injure
    2. Designates safety starter buttons and parts of equipment that may cause electrical shock
    3. Designates exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws

  D. Federal safety purple--Designates radiation hazards

  E. Federal safety green

    1. Designates location of safety equipment
    2. Designates location of first-aid equipment

    (NOTE: This applies to equipment other than fire-fighting equipment.)

  F. Federal safety black and white (used individually or in combination)

    1. Designates traffic flow
    2. Designates housekeeping purposes
    3. Designates storage areas

IV. Rules for general job safety (Assignment Sheet #3)

  A. Keep all tools sharp, clean, and in safe working order

  B. Retain guards and safety devices on all equipment

  C. Report all defective tools, machines, or other equipment to supervisor

  D. Report all accidents to supervisor, regardless of nature or severity

  E. Disconnect power lock and tag out machines before performing maintenance

  F. Use correct, properly fitting wrenches on nuts and bolts

  G. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it

INFORMATION SHEET

- H. Clean up any spilled liquids immediately
- I. Keep work area clear of scraps and litter
- J. Dispose of combustible materials properly

  EXAMPLE: Store oily rags in self-closing metal container.
- K. Do not use compressed air to clean yourself or your clothing
- L. Be conscious of others' safety
- M. Be sure others are at a safe distance when operating moving equipment
- N. Use traffic control devices where required
- O. Follow manufacturer's safety rules and limitations for all equipment
- P. Know procedures governing both public traffic flow and equipment traffic flow on job site

V. Procedures used to maintain a clean and orderly work area

- A. Arrange machinery and equipment to permit safe, efficient work practices and ease in cleaning
- B. Store materials and supplies in proper places
- C. Clear work areas of debris and other hazards
- D. Clean slippery substances from floor
- E. Dispose of waste materials properly
- F. Keep brooms, brushes, and other housekeeping equipment where they are readily available

VI. Personal safety rules

- A. Wear close-fitting clothing that is appropriate for the activity being performed
- B. Confine long hair before operating equipment
- C. Wear safety glasses, suitable hard hats, goggles, hearing protection, and respiratory equipment where required
- D. Remove ties and fasten loose sleeves when working around machine tools or rotating equipment
- E. Remove rings and other jewelry when working

INFORMATION SHEET

F. Be alert and conduct yourself in a manner that will ensure safe practices

G. Use soap and water frequently to prevent skin disease

H. Do not jump onto or from moving equipment

I. Know location of first-aid equipment and fire extinguishers

VII. Order of procedures to lift heavy objects correctly (Transparency #1; Job Sheet #1)

A. Step up to object with feet apart; place one foot beside object and one behind

B. Lift with legs, not with the back

C. Keep back straight, nearly vertical

D. Tuck chin in

E. Grasp object with whole hand

F. Tuck elbows and arms in

G. Hold load close to body

H. Keep body weight directly over feet

VIII. Measures for prevention of injuries from extreme cold

(NOTE: The extent of injury caused by exposure to abnormally cold temperatures depends on additional factors such as wind velocity, type and duration of exposure, temperature, and humidity. Freezing is accelerated by wind and humidity or a combination of the two factors.)

A. Wear proper clothing

B. Limit exposure as much as possible

C. Take frequent, short rest periods

D. Keep moving

(NOTE: Exercise fingers and toes if necessary, but do not overexert.)

E. Do not drink alcohol before exposure to cold

F. Do not bathe before exposure

G. Do not smoke before exposure

H. Learn to recognize the symptoms of overexposure and frostbite

(NOTE: Cold hands may be warmed by placing them under dry clothing against the body, such as in the armpits.)

INFORMATION SHEET

IX. Proper clothing for extreme cold (Assignment Sheet #1)

   A. Thermal-type woolen underwear

   B. Outer clothing which will repel wind and moisture

   C. Face helmet and head and ear coverings

   D. Two pairs of socks

      (NOTE: Carry extra dry socks when working in snow or wet conditions.)

   E. Warm boots

      (NOTE: Make sure boots are not so tight that circulation becomes restricted.)

   F. Wool-lined mittens or gloves covered with wind- and water-repellent material

X. Symptoms of cold exposure

   A. Shivering

   B. Numbness

   C. Low body temperature

   D. Drowsiness

   E. Marked muscular weakness

XI. Order of procedures for treatment of cold exposure (Job Sheet #2)

   A. Get to a warm room as quickly as possible

   B. Remove wet or frozen clothing and anything that is binding

      EXAMPLES: Necklace, watch, ring, belt

   C. Rewarm by adding clothing, wrapping in a blanket, or by getting into a tub of water that is warm *but not hot* to the forearm

      (NOTE: Dry *thoroughly* after soaking in warm tub.)

   D. Drink hot liquids

      (CAUTION: Do not drink alcohol.)

   E. Carry out appropriate procedures as described for frostbite

INFORMATION SHEET

XII. Symptoms of frostbite

(NOTE: Frostbite results when crystals form in the fluids and underlying soft tissues of the skin. The effects are more severe if the injured area is thawed and then refrozen. Frostbite is the most common injury resulting from exposure to cold elements. Usually, the frozen area is small. The nose, cheeks, ears, fingers, and toes are most commonly affected. Just before frostbite occurs, the affected skin may be slightly flushed.)

A. Skin becomes white, gray, or waxy yellow

(NOTE: Color indicates deep tissue damage. Victims are often not aware of frostbite until someone tells them or sees the *pale, glossy skin.*)

B. Skin tingles, then becomes numb

C. Pain may occur, then let up

D. Blisters may form

E. Area of frostbite swells and feels hard

(NOTE: In advanced cases mental confusion and poor judgment occur, the victim staggers, eyesight fails, the victim falls and may pass out, shock is evident, and breathing may cease. Death, if it occurs, is usually due to heart failure.)

XIII. Treatments for frostbite (Job Sheet #2)

A. Protect frozen area from further injury

B. Warm frostbitten part as soon as possible

C. Give artificial respiration if needed

XIV. Measures for prevention of heat stroke, cramps, and heat exhaustion (Assignment Sheet #2)

A. Drink plenty of fluids

B. Increase salt intake by taking salt tablets

C. Do not overexert

D. Wear lightweight clothing

E. Keep head covered and face shaded

F. Take frequent, short work breaks

G. Rest in shade whenever possible

INFORMATION SHEET

XV. Heat stroke, heat cramps, and heat exhaustion (Transparency #2; Assignment Sheet #2, Job Sheet #3)

CONDITION	SYMPTOMS	TREATMENT
HEAT STROKE (NOTE: Heat stroke is an immediate, life-threatening emergency urgently requiring medical attention.)	Visual disturbances Headache, nausea *High* body temperature (may be as high as 106°F) Hot, flushed, *dry* skin Strong, rapid pulse Slow, deep breathing Offensive body odor Possible convulsions Possible loss of consciousness	Cool the body immediately (NOTE: Once temperature is reduced to 102°F, guard against overchilling.) Remove clothing, and sponge with cool (not cold) water or rubbing alcohol Use fans, air conditioners, or fan by hand to circulate air and promote cooling Provide continuous massage toward the heart Give artificial respiration if needed Transport to medical care as soon as possible Do not give stimulants or alcohol EXAMPLES: Colas, beer, coffee, tea
HEAT CRAMPS (NOTE: May precede an attack of heat exhaustion.)	Abdominal pain Nausea, dizziness Pale skin	Get victim to a cool place Exert firm pressure with your hands on the cramped muscles, or gently massage them

INFORMATION SHEET

CONDITION	SYMPTOMS	TREATMENT
HEAT CRAMPS (continued)	Heavy sweating Muscular twitching Severe muscle cramps	Give *sips* of salt water EXAMPLE: One-quarter teaspoon of salt per glass of water, every 15 minutes for an hour (1 teaspoon per quart) Do not give plain (unsalted) cold drinks Do not give stimulants or alcohol EXAMPLES: Colas, beer, coffee, tea
HEAT EXHAUSTION	Approximately normal body temperature Pale, clammy skin Heavy sweating Nausea, possible vomiting Weakness, tiredness Fast, weak pulse Possible fainting (NOTE: Victim will probably regain consciousness as head is lowered.)	(NOTE: Recovery is usually complete, with proper care.) Move victim out of the sun, preferably to an air-conditioned room Loosen clothing Fan Apply cool, wet cloths Give *sips* of salt water EXAMPLE: One-quarter teaspoon per glass of water, every 15 minutes for an hour

INFORMATION SHEET

CONDITION	SYMPTOMS	TREATMENT
HEAT EXHAUSTION (continued)		Allow fluids as desired if victim is able to swallow (NOTE: If victim is vomiting, get him or her to a hospital.) Have victim lie down and raise feet 8"-12" Do not allow victim to return to work for several days Victim should avoid further exposure to abnormally warm temperatures

INFORMATION SHEET

XVI. Procedures for treating bee stings

(NOTE: Bee stings may occasionally cause death due to acute allergic reactions. Persons susceptible to such a reaction should carry proper medication.)

A. Remove stinger and venom sac

(NOTE: Gently scrape stinger out with a sharp object, like a knife. DO NOT SQUEEZE--this will force venom into the tissues.)

B. Wash area with soap and water

C. Apply cold compresses for three minutes

D. Apply soothing lotions such as calamine

(NOTE: Home remedies which will reduce swelling and relieve pain are [1] a paste of meat tenderizer and water or [2] a paste of baking soda and water. Apply to the sting, cover with bandage or clean cloth, leave on the area for at least an hour. Reapply if pain and swelling continue.)

E. Take aspirin for pain if needed

XVII. Procedures for treating severe reactions to bee stings

A. Give artificial respiration if needed

B. If sting is on arm or leg, tie a band above the sting (between sting and heart)

(NOTE: Do not apply tightly. You should be able to slip your finger under the band when it is in place.)

C. Keep affected part down, below level of victim's heart

D. REMOVE BAND AFTER THIRTY MINUTES

(NOTE: If medical help is immediately available, band may remain in place.)

E. Apply to the sting cold cloths or ice contained in a towel or plastic bag

F. Give aspirin for pain

G. If victim has a history of allergic reactions, take victim to hospital or a physician immediately

(CAUTION: Do not wait for symptoms to appear; delay can be fatal.)

INFORMATION SHEET

XVIII. Components of the fire triangle (Transparency #3)

(NOTE: To produce fire, the following three elements are necessary and must be present at the same time. If any one of the three is missing, a fire cannot be started. With the removal of any one of the three, the fire will be extinguished.)

A. Fuel

(NOTE: This is any flammable material.)

B. Heat

(NOTE: There has to be enough heat to raise the fuel to its ignition temperature.)

C. Oxygen

(NOTE: This is necessary to sustain combustion.)

XIX. Classes of fires

A. Class A--Fires that occur in ordinary combustible materials such as wood, rags, and rubbish

B. Class B--Fires that occur with flammable liquids such as gasoline, oil, grease, paint, and thinners

C. Class C--Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring

(CAUTION: Do *not* use pressurized water.)

D. Class D--Fires that occur with combustible metals such as iron or magnesium

XX. Types of fire extinguishers to use on classes of fires (Transparency #4)

(NOTE: On Class D fires, dry sand is as effective as any chemical.)

A. Pressurized water--Use on Class A fires *only*

B. Carbon dioxide (CO_2)--Used on Class B and C fires

C. Multipurpose dry chemical--Used on Class A, B, and C fires

D. Special purpose dry chemical--Used on Class B and C fires

E. Water pump tank--Used on Class A fires *only*

INFORMATION SHEET

XXI. Safety rules concerning flammable liquids

A. Know the location and use of fire extinguishers for flammable liquids

B. Store all flammable liquids in approved safety containers

C. Use only approved cleaning solvents to clean parts

(CAUTION: Never use gasoline.)

D. Do not operate an engine that is leaking gasoline

E. Change oil-soaked or gasoline-soaked clothing immediately

F. Do not fuel a running engine

XXII. Rules for traveling equipment on public roads

A. Drive slowly

(CAUTION: Never speed; heavy equipment such as dozers or motor graders were not designed for speed and will easily "duckwalk" out of control.)

B. Know your stopping distance

C. Allow extra time to enter traffic

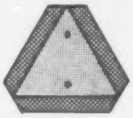
D. Stay in the extreme right lane or on shoulder

E. Travel with lights on

F. Use proper warning signs and flags

EXAMPLES: Twelve-inch square red flags for day travel, warning signal visible for 500 feet for night travel, SMV (Slow Moving Vehicle) emblem (Figure 2)

FIGURE 2



G. Secure all attachments and loose gear

H. Turn cautiously; allow for extensions or attachments and for structure clearance

(NOTE: Some equipment is top-heavy and will tip over if the turn is made too fast.)

I. Know and obey state and local laws

INFORMATION SHEET

XXIII. Signal procedures in case of breakdown (Transparencies #5 and #6; Assignment Sheet #4)

A. Carry safety signal devices

EXAMPLES: A minimum of three flares, fuses, or pot torches *or* three red electric lanterns; *or* three red reflectors; *or* three 12-inch square red flags with standards to support them

(NOTE: Signals must be visible at 500 feet under normal conditions.)

B. Pull off the road

C. Place one signal 100 feet (40 paces) ahead of equipment

D. Place second signal 100 feet (40 paces) to rear of equipment

E. Place third signal as near as is practical to side of equipment near traffic

(NOTE: If disabled on a divided highway, place rear signal 200 feet [80 paces] from equipment. If disabled on a curve or hill crest or other such obstruction, place signal where it will give ample warning, but not more than 500 feet nor less than 100 feet from equipment.)

XXIV. Rules for personal job site safety

A. Read safety manual thoroughly and follow suggested procedures

B. Keep alert at all times

C. Use handholds to mount equipment

(CAUTION: Do not use control levers or the steering wheel.)

D. Never mount or dismount a moving vehicle

E. Don't jump onto or from equipment

F. Look and listen for equipment defects

(CAUTION: Stop immediately if you sense a problem.)

G. Be sure you have adequate ventilation

H. Keep in mind that you are an operator of *heavy equipment* and act *responsibly*

INFORMATION SHEET

XXV. Procedures for traveling equipment on job site

A. Never travel a machine on a job site, in a congested area, or around people without a spotter to guide you

(NOTE: The spotter is responsible for determining and controlling driver's speed.)

B. Be sure everyone is in the clear before and while backing, hooking up, or moving attachments

C. Never move pipe or similar items over the heads of other workers

D. If you cannot see your area clearly from the operator's seat and have no spotter, dismount and examine for possible hazards

E. Wait for an "all-clear" before moving

F. Signal a forward move with two blasts of horn

G. Signal a reverse move with three blasts of horn

H. Give right-of-way to loaded equipment on haul roads and in pits

I. Maintain safe distance from other vehicles

J. Keep in gear at all times; never coast

K. Maintain a ground speed consistent with ground conditions

L. Pass only when necessary; use caution

M. Watch for overhead electrical power lines

(NOTE: Equipment does not have to come in direct contact with wires to act as a conductor. If operating near power lines, power to lines should be shut off, or lines should be insulated.)

(CAUTION: Do not operate within 10 feet of power lines.)

N. Watch for flags indicating buried pipes and power and gas lines

(NOTE: Telephone and utility companies will flag the work site when needed with colored flags: gas and chemicals, *yellow*; phone, *orange*; electric, *red*; water, *blue*; sanitary and storm sewers, *green*.)

XXVI. Factors affecting traffic controls for maintenance operations

A. Speed

B. Volume of traffic

C. Maneuvering space

INFORMATION SHEET

D. Frequency of turns

E. Frequency of cross movement

F. Pedestrian movement

G. Type of operation

EXAMPLES: Stationary, mobile

H. Duration of operation

EXAMPLES: Two or three hours, two or three days

I. Other obstructions

EXAMPLES: Large signs, bridge abutments, sharp curves

XXVII. Rules for use of traffic control devices (Transparency #7)

A. Install before maintenance operation gets underway

B. Maintain properly during operations

C. Allow to remain in place only as long as needed; remove immediately thereafter

D. When operations are performed in stages, use only those devices that apply to conditions present

E. Perform sign and barricade installation in a responsible manner

F. Keep signs and barricades free from visual obstructions

EXAMPLES: Weeds, shrubbery, construction materials, equipment

XXVIII. Rules for proper placement of signs

(NOTE: Under special circumstances, appropriate use of traffic control devices will be determined by supervisor.)

A. Place where they will convey messages most effectively according to highway design, highway alignment, and speed

B. Place at a distance that allows driver adequate time to respond

C. Place on right side of street or roadway

(NOTE: Where special emphasis is needed, install duplicate signs opposite each other on right and left sides.)

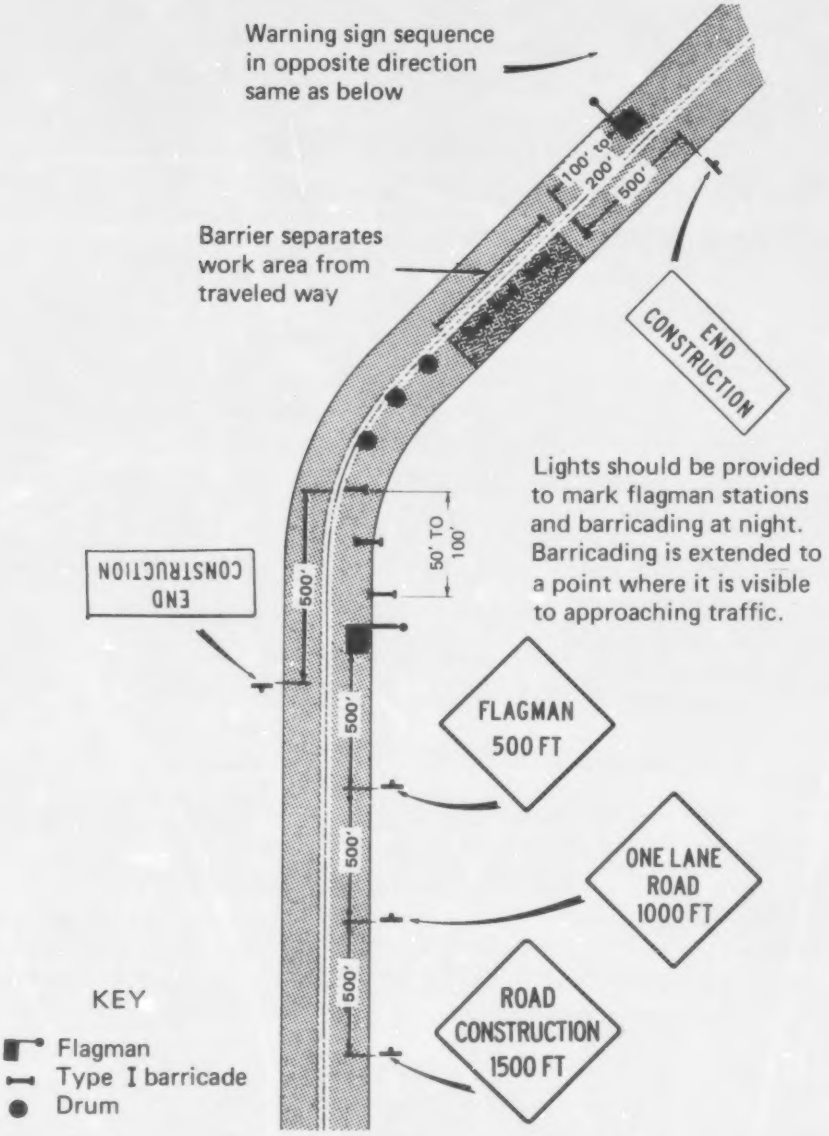
D. Place in traffic lane when appropriate

INFORMATION SHEET

E. Place advance warning signs approximately 1,500 feet in advance of work area at 500-foot intervals where open highway conditions prevail (Figures 3 and 4)

EXAMPLES:

FIGURE 3


100' to 200'
500'
END CONSTRUCTION
50' TO 100'
500'
END CONSTRUCTION
500'
FLAGMAN 500 FT
500'
ONE LANE ROAD 1000 FT
500'
ROAD CONSTRUCTION 1500 FT

Warning sign sequence in opposite direction same as below

Barrier separates work area from traveled way

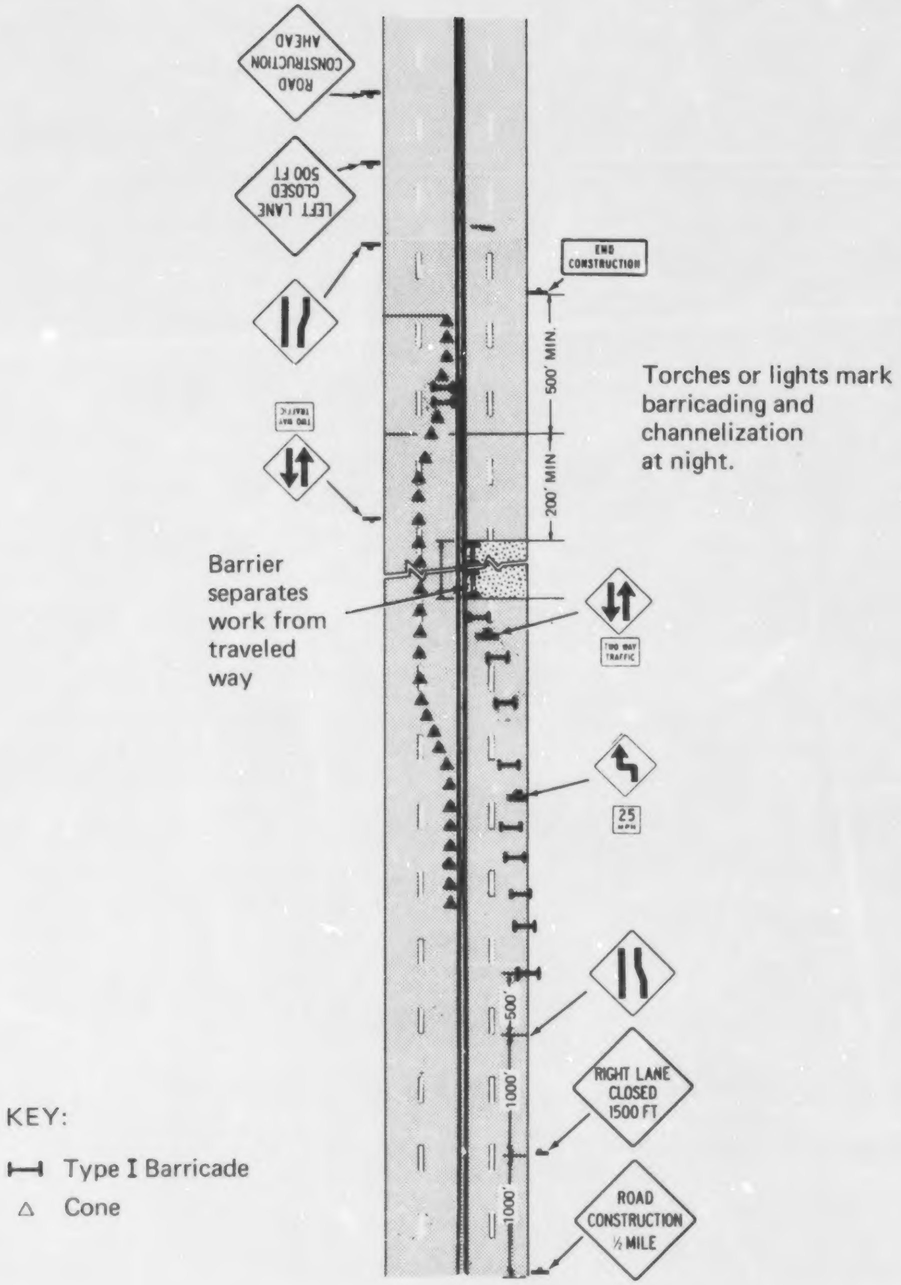
Lights should be provided to mark flagman stations and barricading at night. Barricading is extended to a point where it is visible to approaching traffic.

KEY

▮ Flagman
━ Type I barricade
● Drum

INFORMATION SHEET

FIGURE 4


ROAD CONSTRUCTION AHEAD
LEFT LANE CLOSED 500 FT
TWO WAY TRAFFIC
END CONSTRUCTION
500' MIN.
200' MIN
TWO WAY TRAFFIC
25 MPH
500'
1000'
RIGHT LANE CLOSED 1500 FT
1000'
ROAD CONSTRUCTION ½ MILE

Torches or lights mark barricading and channelization at night.

Barrier separates work from traveled way

KEY:

⊢⊣ Type I Barricade

△ Cone

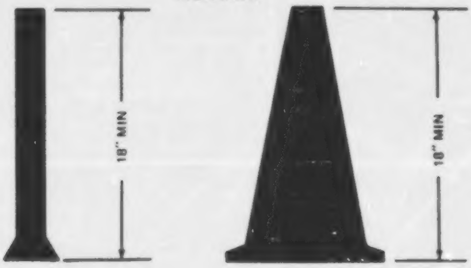
INFORMATION SHEET

XXIX. Channeling devices and their uses (Figures 5-10; Assignment Sheet #5)

A. Cones--Used to guide traffic along a regular channel

(NOTE: Cones may become displaced by traffic. They should be patrolled and replaced as necessary.)

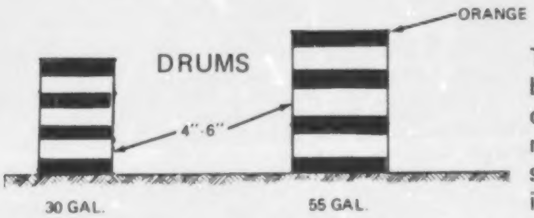
FIGURE 5 CONES



B. Drums--Used to mark an unusual vehicle path

EXAMPLES: Mark the edge of pavement; channel traffic away from an open trench alongside pavement; provide working room for maintenance activity

FIGURE 6

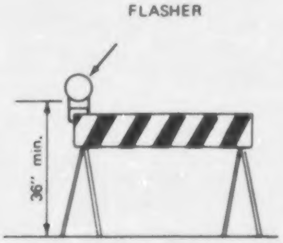


The drums are to be predominately orange, but a minimum of 2 white stripes per drum is required.

Adjustments due to odd size drums should be divided between the upper and lower stripes.

C. Portable flasher support--Used at points of special hazard

FIGURE 7



PORTABLE FLASHER SUPPORT

INFORMATION SHEET

D. Type I and Type II barricades--Used when traffic is maintained through area being repaired

(NOTE: Type I and Type II barricades are interchangeable. Usually Type I is heavier and more bulky.)

FIGURE 8

TYPE I BARRICADE

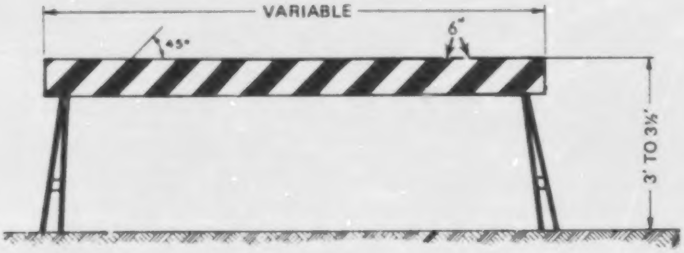
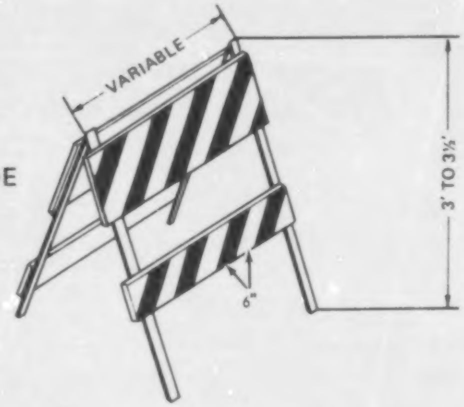

VARIABLE
45°
6"
3' TO 3½'

FIGURE 9

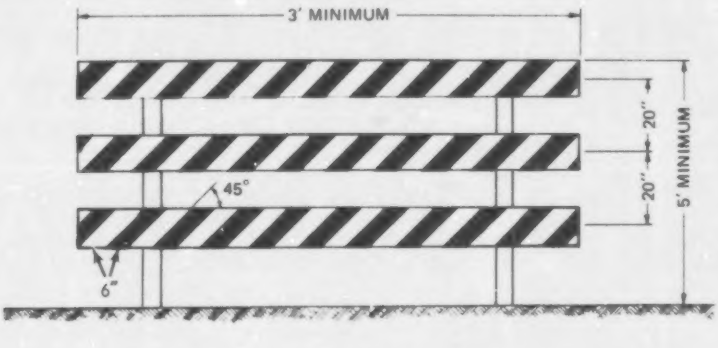
TYPE II BARRICADE


VARIABLE
3' TO 3½'
6"

E. Type III barricades--Used at points of closure

FIGURE 10

TYPE III BARRICADE


3' MINIMUM
20"
20"
5' MINIMUM
45°
6"

INFORMATION SHEET

XXX. Responsibilities of flag person (Assignment Sheet #6)

A. Protecting public, other workers, and self

B. Promoting good public relations

(NOTE: The flag person has the most public contact. When practical, the flag person should tell motorists the reason and the approximate length of delay.)

C. Stopping or slowing traffic

D. Releasing traffic when it is safe to proceed

E. Alerting drivers to traffic conditions

XXXI. Flagging positions (Figures 11-16; Job Sheets #4, #5, and #6)

A. Stopping traffic

FIGURE 11 Flag

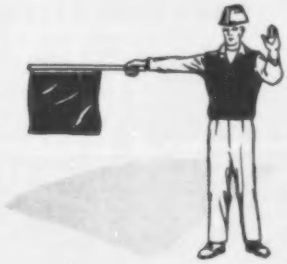
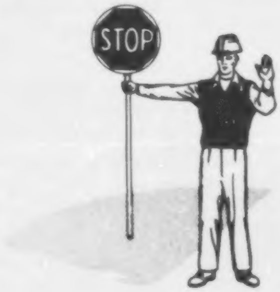


FIGURE 12 Paddle



B. Releasing traffic when it is safe to proceed

FIGURE 13

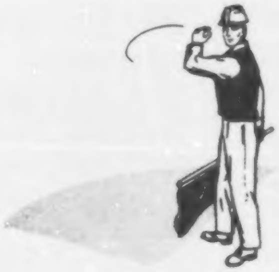
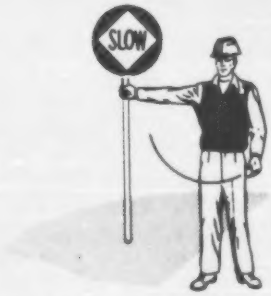


FIGURE 14



INFORMATION SHEET

C. Alerting drivers or slowing traffic

FIGURE 15

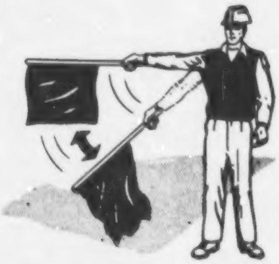
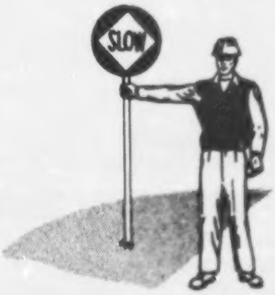


FIGURE 16



XXXII. Safety rules for flag persons (Assignment Sheet #6)

(NOTE: Never assume that all motorists are alert and watching. If you suspect that a driver is careless or erratic, warn your co-workers.)

A. Wear a hard hat and a reflective vest

B. Stand where you can be seen by oncoming traffic for 500 feet or more

C. Stand 100 - 200 feet from work area

(NOTE: One hundred feet is approximately 40 paces.)

D. Stand in safe position on shoulder, never in path of approaching vehicles

E. Stand sideways to traffic

(NOTE: Stand in such a way that you can watch the cars *and* the signal person to your rear. NEVER turn full back to traffic.)

F. Use either a STOP/SLOW paddle or a 24-inch-square red flag for daylight flagging

G. For night flagging, use a flashlight with an 8-inch red wand

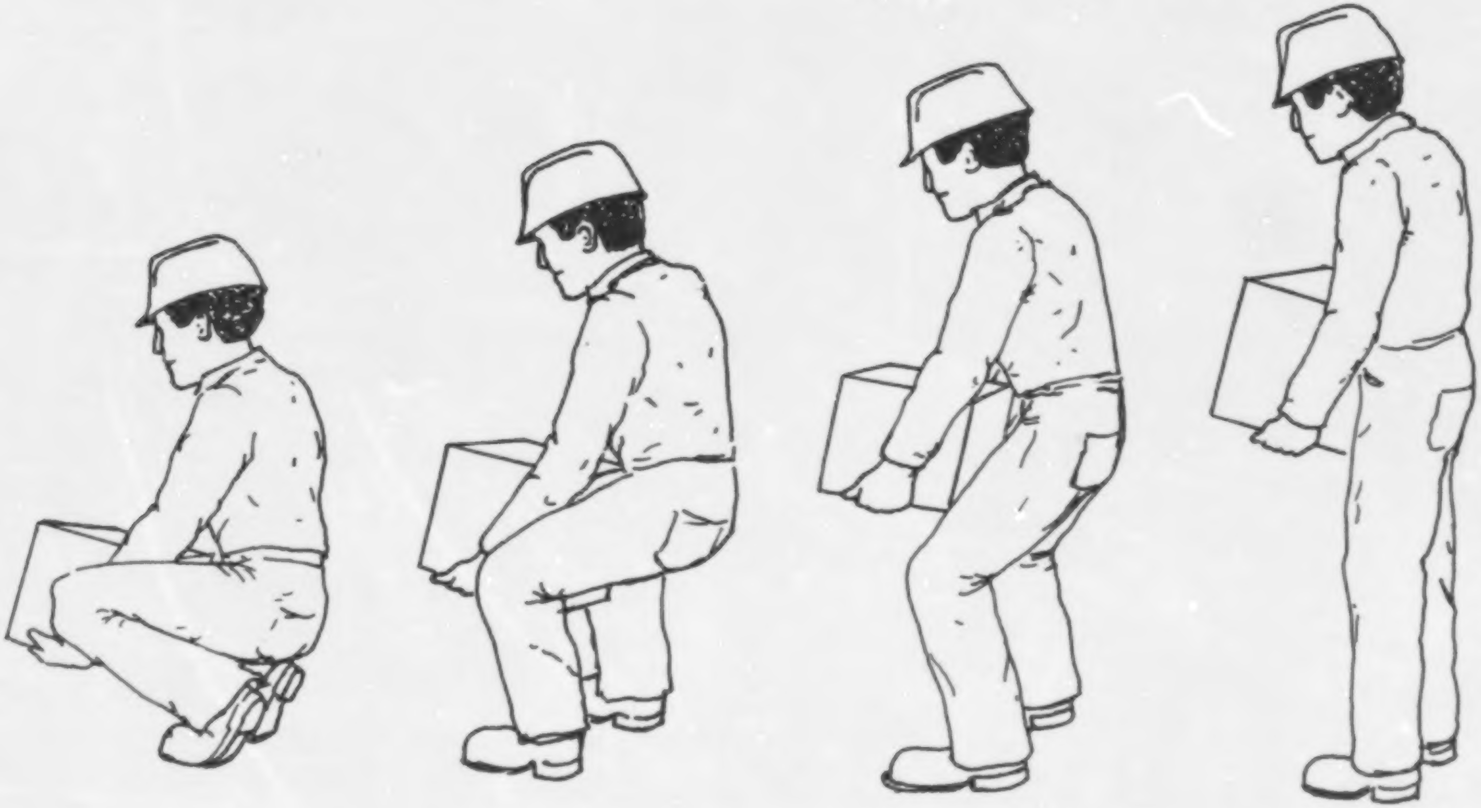
H. Always stand alone; never mingle with maintenance crew

I. Remain at your station until properly relieved or until job is ended

J. When communicating with other flaggers, use verbal signals or hand signals which will not be mistaken for flagging signals

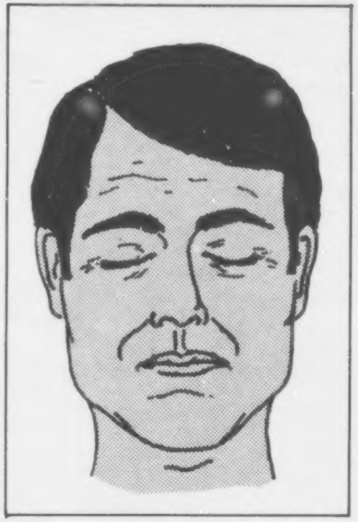
K. Remove all traffic control signs when work has ended

Correct Way to Lift Heavy Objects



Face and Skin Conditions in Heat Stroke and Heat Exhaustion

Heat Stroke



Skin Condition

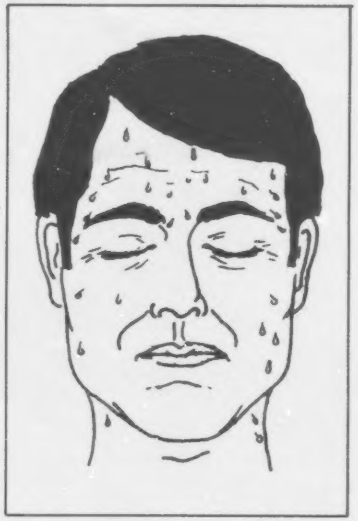
Hot Red Dry

Get Immediate Medical Help

Cool body as quickly as possible

TM #2

Heat Exhaustion



Skin Condition

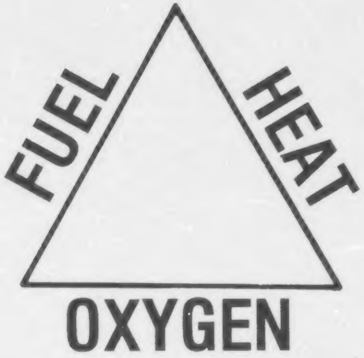
Clammy Pale Heavy Sweating

Get victim out of sun and heat, elevate feet, cool body, give sips of salt water

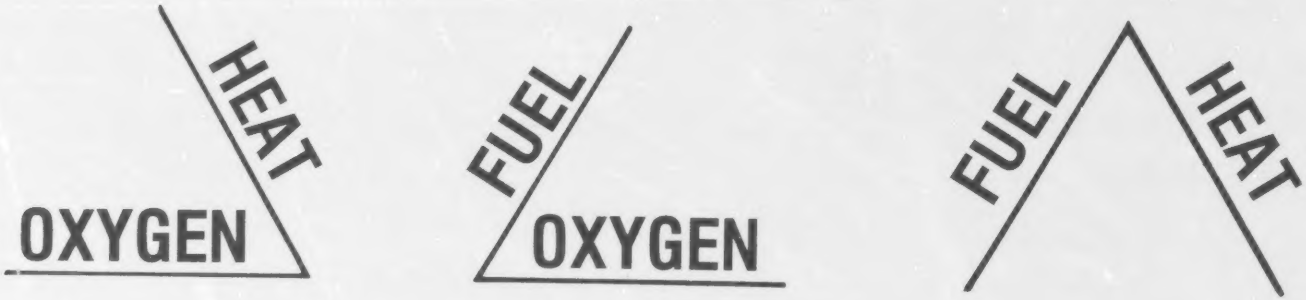
DOT I-73

The Fire Triangle

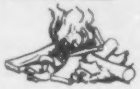
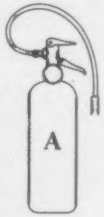
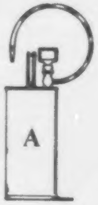
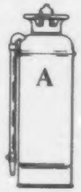
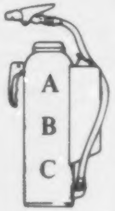
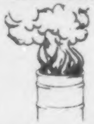
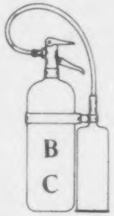
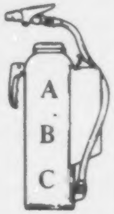
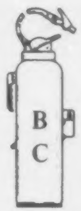
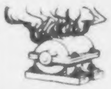
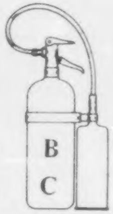
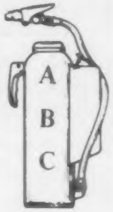
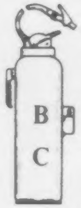
To produce fire, three things must be present at the same time.


FUEL
HEAT
OXYGEN

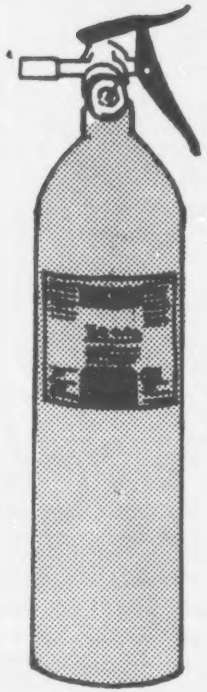
If any one of the three is missing, a fire cannot be started. With the removal of any one, the fire will be extinguished.


HEAT
OXYGEN
FUEL
OXYGEN
FUEL
HEAT

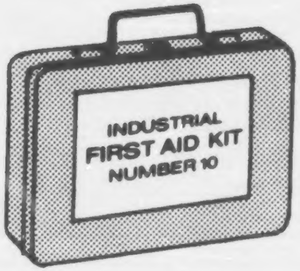
Types of Fire Extinguishers

KIND OF FIRE		APPROVED TYPE OF EXTINGUISHER					
		MATCH PROPER EXTINGUISHER WITH CLASS OF FIRE SHOWN AT LEFT Important! Using the wrong type extinguisher for the class of fire may be dangerous.					
DECIDE THE CLASS OF FIRE YOU ARE FIGHTING...	...THEN CHECK THE COLUMNS TO THE RIGHT OF THAT CLASS	**CARBON DIOXIDE** Carbon Dioxide Gas Under Pressure	**STORED PRESSURE** Pressurized Water	**PUMP TANK** Plain Water	**GAS CARTRIDGE** Water Expelled by Carbon Dioxide Gas	**MULTI-PURPOSE DRY CHEMICAL**	**SPECIAL PURPOSE DRY CHEMICAL**
A 	**CLASS A FIRES Use These Extinguishers** **ORDINARY COMBUSTIBLES** • Wood • Paper • Cloth, Etc.						
B 	**CLASS B FIRES Use These Extinguishers** **FLAMMABLE LIQUIDS, GREASE** • Gasoline • Paints • Oils, Etc.						
C 	**CLASS C FIRES Use These Extinguishers** **ELECTRICAL EQUIPMENT** • Motors • Switches, Etc.						

Safety Equipment to be Carried on all Vehicles

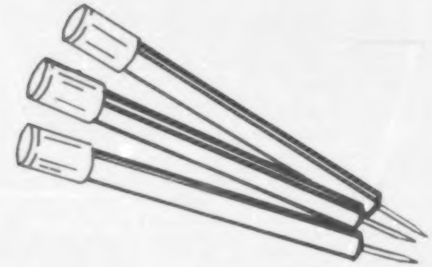


Fire Extinguisher


INDUSTRIAL
FIRST AID KIT
NUMBER 10

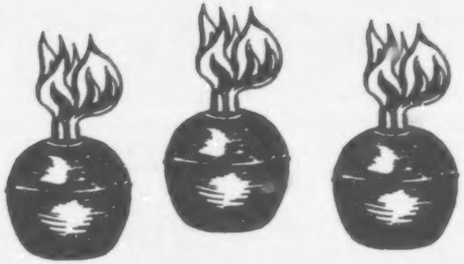
First-Aid Kit

Emergency Signals to be Carried in Vehicle

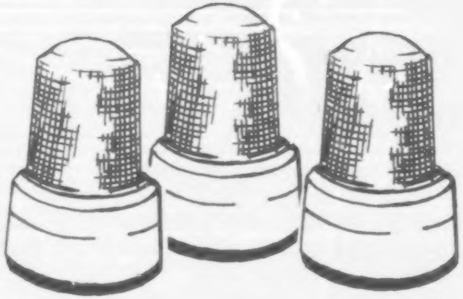


Three Flares

or

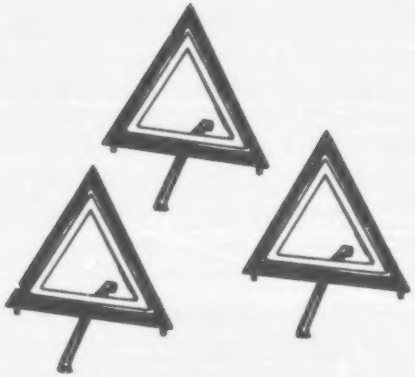


Three Pot Torches



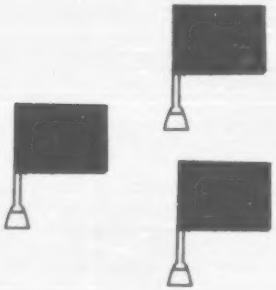
Three Red Electric Lanterns

or



Three Red Reflectors

or



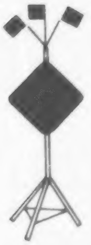
Three Red Flags
and Stands

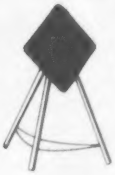
TM #6

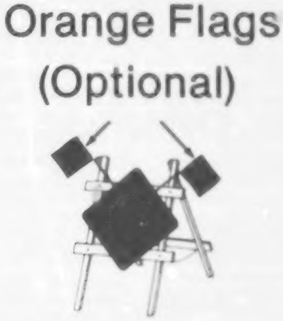
DOT I-81

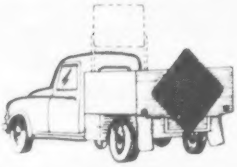
Examples of Portable and Temporary Mountings

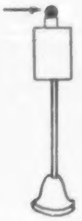
Portable and Temporary Mountings

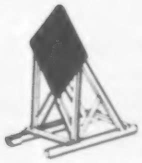




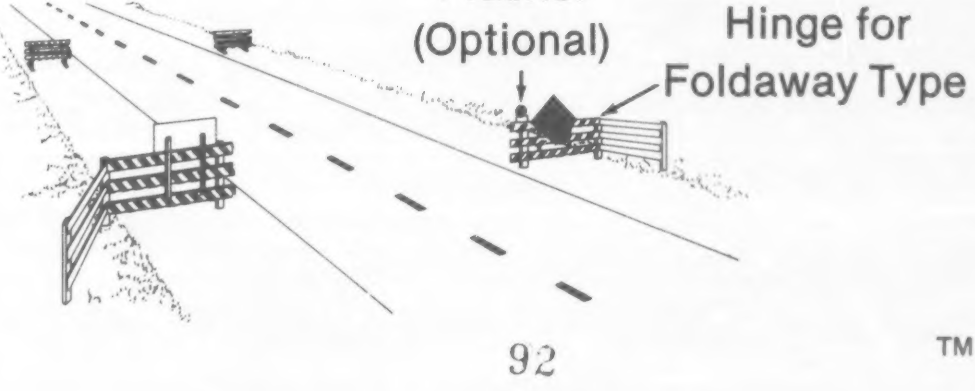

Orange Flags
(Optional)




Flasher
(Optional)



Wing Barricades


Flasher
(Optional)
Hinge for
Foldaway Type

SAFETY
UNIT II

ASSIGNMENT SHEET #1--COMPILE A SURVEY OF WINTER CLOTHING NEEDS

NAME ______________________________ SCORE ______________

Highway maintenance requires operators to work in extreme weather conditions. It is essential for the worker to be well-prepared and protected against exposure to cold and frostbite.

Survey your own clothing. Make a list of the winter gear you already have. Make another list of the items you need to ensure proper protection.

A. Clothing you have--______________________________

____

____

____

____

____

____

____

____

____

B. Clothing you need--______________________________

____

____

____

____

____

____

____

____

____

SAFETY
UNIT II

ASSIGNMENT SHEET #2--DISTINGUISH AMONG SYMPTOMS AND TREATMENTS FOR HEAT STROKE, HEAT CRAMPS, AND HEAT EXHAUSTION

NAME ______________________ SCORE ____________

Exposure to extreme heat combined with exertion can result in heat stroke, heat cramps, or heat exhaustion. Because each condition requires immediate recognition, followed by appropriate treatment, it is essential that the worker be able to distinguish the different symptoms of the three conditions.

Distinguish among symptoms and treatments for heat stroke, heat cramps, and heat exhaustion. Write an "X" in the appropriate column(s).

A. SYMPTOMS	STROKE	CRAMPS	EXHAUSTION
1. Heavy sweating	_______	_______	_______
2. Leg muscle cramps	_______	_______	_______
3. Weakness, tiredness	_______	_______	_______
4. Strong, rapid pulse	_______	_______	_______
5. Nausea	_______	_______	_______
6. Hot, dry skin	_______	_______	_______
7. Fainting	_______	_______	_______
8. Headache	_______	_______	_______
9. High body temperature	_______	_______	_______
10. Pale, clammy skin	_______	_______	_______
11. Loss of consciousness	_______	_______	_______
12. Abdominal pain	_______	_______	_______
13. Approximately normal body temperature	_______	_______	_______
14. Flushed skin	_______	_______	_______

ASSIGNMENT SHEET #2

B.	TREATMENTS	STROKE	CRAMPS	EXHAUSTION
1.	Massage muscles gently	______	______	______
2.	Raise feet 8"-12"	______	______	______
3.	Transport to medical care as soon as possible	______	______	______
4.	Loosen clothing	______	______	______
5.	Sponge body with cool water or rubbing alcohol	______	______	______
6.	Give sips of salt water	______	______	______
7.	Get to an air-conditioned room or place by a fan	______	______	______

SAFETY
UNIT II

ASSIGNMENT SHEET #3--ANALYZE ACCIDENT CASE STUDIES

NAME ______________________ SCORE ____________

SAFETY IS A PERSONAL RESPONSIBILITY. Without a doubt most accidents result from taking careless risks. Not only can accidents cause physical harm and loss of work time, but unsafe situations and actions affect your co-workers and company.

Study each of the case studies that follow. Think through them carefully. What caused the accidents? Could they have been avoided? What "costs" were involved besides financial ones?

ASSIGNMENT SHEET #3

CASE STUDY #1

Victim: Jane Perkins, age 29, seven years' experience

Job Description: Using hydraulic crane to lift materials

Accident Description: Jane allowed the hydraulic crane boom to come too close to an electrical power line. She remained in the cab and did not touch the machine's metal structure until the boom was cleared of the wire. However, in her haste to be free of the situation, she left the cab without cutting off the power or properly locking the controls. As she dismounted, the crane moved forward, severely gashing her shin.

A. Assuming that you have witnessed the accident and are nearby to help, what would you do first?

____

____

____

B. What safety precautions did the worker observe? ______________

____

____

C. What safety precautions did the worker fail to observe? ______________

____

____

D. What factors may have caused the accident? ______________

____

____

E. Could this accident have been avoided?______________How? ______________

____

____

F. What do you think will be some of the consequences or results of this accident?

____

____

____

ASSIGNMENT SHEET #3

CASE STUDY #2

Victim: Joel McCreedy, age 22, five months' experience

Job Description: Using a front-end loader to load soil material into a truck

Accident Description: Joel was leveling a work area. His motor stopped, and he could not start it with cranking. Joel jumped from the machine to check the battery. He laid a steel wrench across the battery posts to determine the charge. Because the air directly over the battery was filled with hydrogen gas, the heavy sparks caused the battery to explode. Joel was thrown to the ground with acid burns to his hands, face, and eyes.

A. Assuming that you have witnessed the accident and are nearby to help, what would you do first?

B. What safety precautions did the worker observe?

C. What safety precautions did the worker fail to observe?

D. What factors may have caused the accident?

E. Could this accident have been avoided? How?

F. What do you think will be some of the consequences or results of this accident?

ASSIGNMENT SHEET #3

CASE STUDY #3

Victim: Lee Quentin, age 36, 15 years' experience

Job Description: Moving a compressor with an oil leak from the shop to a nearby storage shed

Accident Description: Lee had just returned from a noon dental appointment when his supervisor asked him to move a compressor with an oil leak from the shop to a nearby storage shed. It was raining when Lee went outside to get a dolly to move the compressor. On returning, he stepped up to the machine, slipped on the oily floor, and fell. His head struck the concrete floor, and he was knocked unconscious.

A. Assuming that you have witnessed the accident and are nearby to help, what would you do first?

____

____

____

B. What safety precautions did the worker observe? ____________________

____

____

C. What safety precautions did the worker fail to observe? ________________

____

____

D. What factors may have caused the accident? ________________________

____

____

E. Could this accident have been avoided?______________How? ____________

____

____

F. What do you think will be some of the consequences or results of this accident?

____

____

____

ASSIGNMENT SHEET #3

CASE STUDY #4

Victim: Elsworth Barnes, age 20, four months' experience

Job Description: Driving a loader from one job site to another

Accident Description: Proud to be given the responsibility of traveling a loader on a public highway from one work site to another five miles away, Elsworth tipped his hard hat at passing motorists and recklessly increased his speed. His loader suddenly "duckwalked" off the road and went down an 8-foot embankment. The loader rolled over, crushing Elsworth, who died instantly.

A. Assuming that you have witnessed the accident and are nearby to help, what would you do first?

B. What safety precautions did the worker observe? ______________________

C. What safety precautions did the worker fail to observe? ______________________

D. What factors may have caused the accident? ______________________

E. Could this accident have been avoided? ______________ How? ______________

F. What do you think will be some of the consequences or results of this accident?

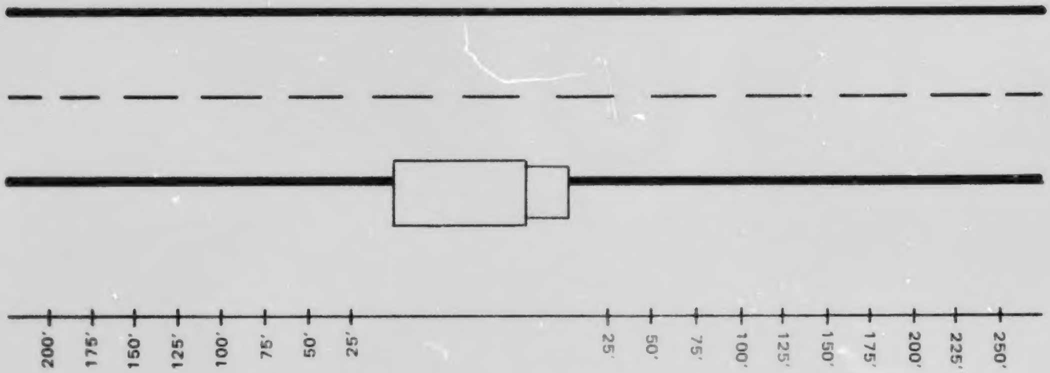
SAFETY
UNIT II

ASSIGNMENT SHEET #4--LOCATE CORRECT PLACEMENT FOR EMERGENCY SIGNALS IN THE EVENT OF BREAKDOWN

NAME ______________________ SCORE ____________

Correct placement of emergency signals is necessary to protect the worker, the public, and equipment.

A. Draw Xs to show the proper placement of three signals (flares, red reflectors, red electric lanterns, or flags).


200'
175'
150'
125'
100'
75'
50'
25'
25'
50'
75'
100'
125'
150'
175'
200'
225'
250'

B. 40 paces equal _____ feet

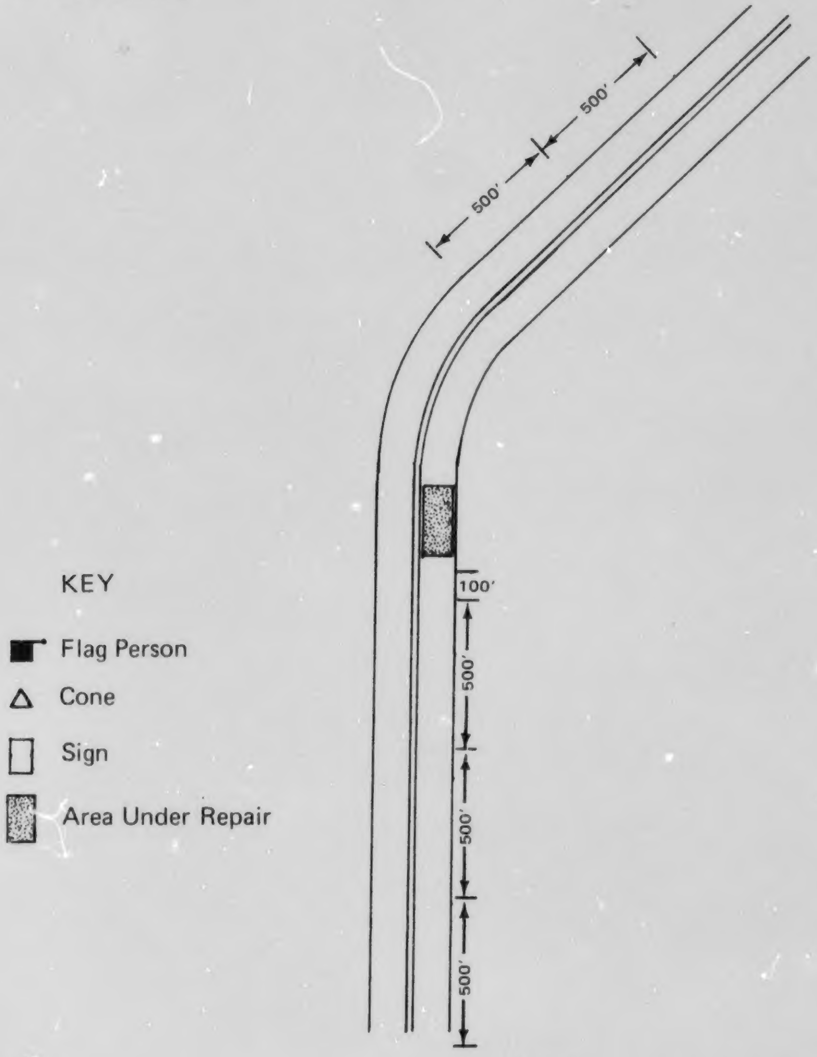
SAFETY
UNIT II

ASSIGNMENT SHEET #5--CONSTRUCT A DIAGRAM OF APPROPRIATE TRAFFIC CONTROL FOR A TWO-LANE ROADWAY

NAME ______________________________ SCORE ______________

Channeling is the most important element in traffic control and safety, both for the operations crew and the public. Every operation will include installation of traffic control devices.

On the stretch of highway below, draw in the appropriate signs, cones, barricades, and flag persons for effective traffic control. Assume that you have available any of the devices you have studied.


500'
500'
100'
500'
500'
500'
KEY
Flag Person
Cone
Sign
Area Under Repair

SAFETY
UNIT II

ASSIGNMENT SHEET #6--DISTINGUISH BETWEEN CORRECT AND INCORRECT PROCEDURES FOR FLAG PERSONS

NAME ______________________________ SCORE ______________

Correct safety procedures for flagging are necessary to protect the flagger, fellow workers, and the public.

The following is a description of Janice Wilson funneling traffic into a single lane on a bridge. After each statement, mark whether Janice's actions were correct or incorrect by writing an "X" in the appropriate blank.

		CORRECT	INCORRECT
A.	Janice wears a hard hat and a reflective vest	________	________
B.	She stands in the traffic lane to move the cars into the changed lane	________	________
C.	She uses a 24-inch STOP/SLOW paddle	________	________
D.	Janice can be seen by oncoming traffic 500 feet before the bridge	________	________
E.	She stands about 250 feet from the bridge	________	________
F.	While she is waiting for cars to come from the other end of the bridge, she turns and watches the bridge operation	________	________
G.	She carries a flashlight with an 8-inch red wand for night flagging	________	________
H.	She and the flag person at the other end of the bridge signal each other by clasping their hands over their heads	________	________
I.	After her traffic is stopped, she takes a quick look at the other flag person for a signal	________	________
J.	She takes her breaks promptly at 10:15 and 3:15, at which time her relief is supposed to cover for her	________	________
K.	At 4:30 when the crew stops for the day, Janice puts the signs out of view of motorists	________	________
L.	Andy came over to Janice's station to ask her for a date; Janice told him to keep clear of her station, she would talk to him on her break	________	________

SAFETY
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1--Evaluated to the satisfaction of the instructor

Assignment Sheet #2

A. SYMPTOMS

1. Exhaustion, cramps
2. Cramps (student may include exhaustion)
3. Exhaustion
4. Stroke
5. Stroke, cramps, exhaustion
6. Stroke
7. Stroke, exhaustion
8. Stroke
9. Stroke
10. Exhaustion
11. Stroke, exhaustion
12. Cramps (student may include exhaustion)
13. Exhaustion
14. Stroke

B. TREATMENTS

1. Cramps (may include *stroke* treatment: Provide continuous massage toward the heart.)
2. Exhaustion
3. Stroke
4. Exhaustion (student may include stroke)

ANSWERS TO ASSIGNMENT SHEETS

5. Stroke (student may include exhaustion)
6. Cramps, exhaustion
7. Stroke, exhaustion

Assignment Sheet #3

(NOTE: Some of the answers below include information or conclusions not covered in the information sheets. Instructor should discuss these answers with students to broaden their understanding of safety practices. Evaluate answers according to average responses for this assignment sheet.)

Case Study #1

Student responses will vary, but answers should include the following

A. Shut down crane, or call someone else to shut down crane while you attend to victim.

B. Jane remained in the crane and did not touch the cab's metal structure until the boom was cleared from the wire.

C. Jane failed to observe the recommended safe distance of separation between crane boom and high power lines. (After seven years' experience, she should have known that it is not necessary to come in contact with a high power line for the electrical energy to ground through the machine.) She dismounted without shutting down the machine or lowering and locking the boom.

D. Jane did not observe safety precautions for working near utility lines. Also, she used poor judgment (panicked) when dismounting the crane, and thus failed to shut down the machine properly.

E. Yes. Jane could have avoided the accident by observing the safety rules pertaining to working with a crane around high power wires and dismounting a machine.

F. Accident results include damage to equipment, perhaps some property damage, personal injury, time lost from work, and perhaps some delay in work schedule.

Case Study #2

Student responses will vary, but answers should include the following

A. Try to calm victim and keep him from touching his face.

B. Joel was smoothing (leveling) a work area before beginning his job.

C. Joel jumped from his machine rather than using the steps and grab irons; he checked the battery charge by placing a metal object across the posts rather than by using a proper tool--a voltmeter or hydrometer.

ANSWERS TO ASSIGNMENT SHEETS

D. The accident may have been caused by Joel's inexperience. His carelessness and his failure to follow recommended safety precautions when testing a battery were certainly contributing causes.

E. Yes. Joel could have avoided the accident by having a thorough knowledge of the machine in question, and by observing safety rules pertaining to checking a battery charge.

F. Accident results include permanent personal injury, damage to equipment, time lost from work (perhaps permanent).

Case Study #3

Student responses will vary, but answers should include the following

A. Observe overall emergency. (Lee may have suffered a concussion or head wound.)

B. Lee planned to use a dolly to move a heavy object.

C. Lee neglected to wipe up a spill in the work area.

D. The combination of wet shoes and oil on the floor probably caused the accident.

E. Yes. Lee could have avoided the accident by wiping up the spilled oil on the work area floor.

F. Accident results include personal injury and time lost from work.

Case Study #4

Student responses will vary, but answers should include the following

A. Turn off machine if possible.

B. Elsworth wore his hard hat.

C. Elsworth failed to drive at the low speed recommended for safe traveling. Elsworth's supervisor, however, bears most of the responsibility for this accident. The operator was too inexperienced to be traveling a loader. Further, five miles is too great a distance to travel a loader. The machine should have been transported to the work site on a transport. Large, heavy machines are not designed for open-road extended travel.

D. The accident was caused by carelessness on the part of Elsworth's supervisor and by Elsworth's recklessness.

E. Yes. Elsworth should have driven the machine more slowly. The supervisor should have chosen someone more experienced for the job, should have trained his workers to the dangers of the equipment, and should not have allowed the machine to be traveled to the other work site.

F. Accident results include death, destruction of equipment and property, loss of a worker, and delay in work schedule.

ANSWERS TO ASSIGNMENT SHEETS

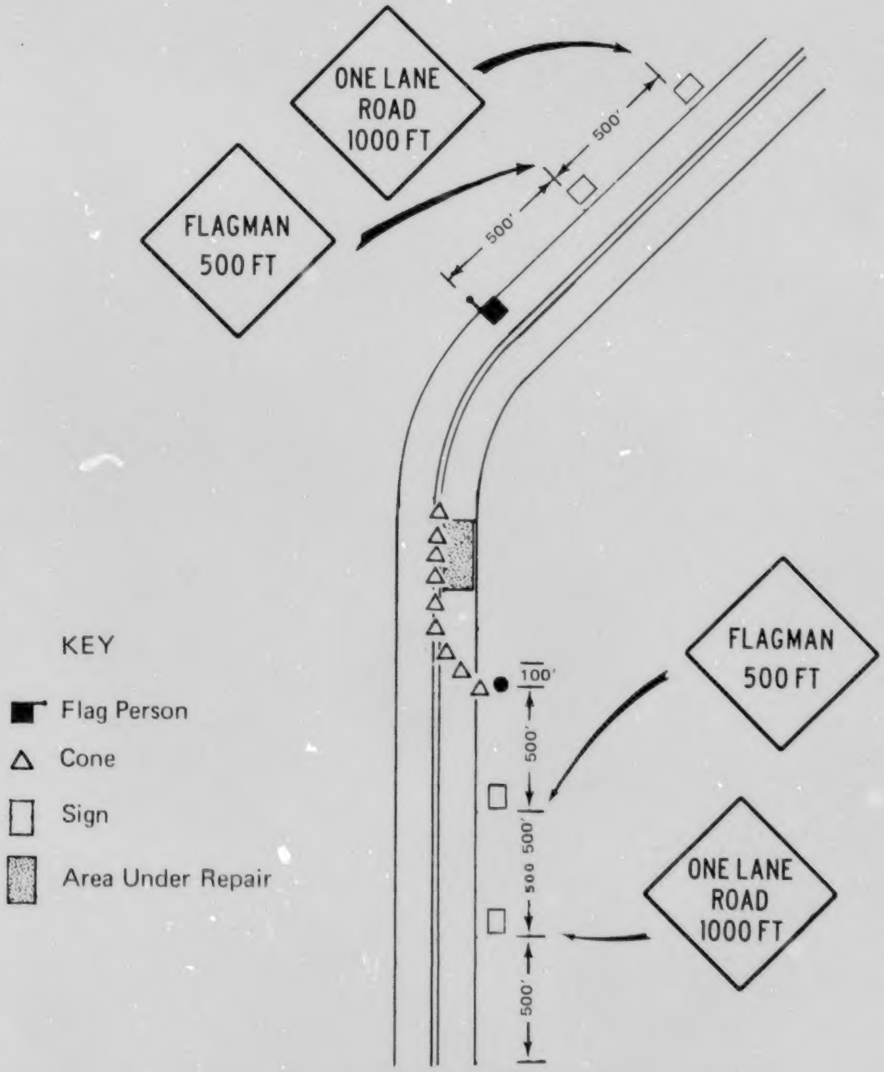
Assignment Sheet #4

A. One signal 100 feet ahead of the equipment; one signal 100 feet to the rear of the equipment; one signal on the side toward the traffic lane

B. 100

Assignment Sheet #5

Below is one possible solution. Any appropriate solution is acceptable as evaluated to satisfaction of instructor


ONE LANE ROAD 1000 FT
FLAGMAN 500 FT
500'
500'
100'
500'
500 500'
500'
FLAGMAN 500 FT
ONE LANE ROAD 1000 FT
KEY
Flag Person
Cone
Sign
Area Under Repair

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #6

A. Correct

B. Incorrect

C. Correct

D. Correct

E. Incorrect

F. Incorrect

G. Correct

H. Correct

I. Correct

J. Incorrect

K. Correct

L. Correct

SAFETY
UNIT II

JOB SHEET #1--SHOW THE CORRECT WAY TO LIFT

(NOTE: It is understood that each student will be given proper lifting instruction before attempting to lift a heavy object. It is also advised that students view the film *A New Way to Lift.*)

I. Personnel and equipment

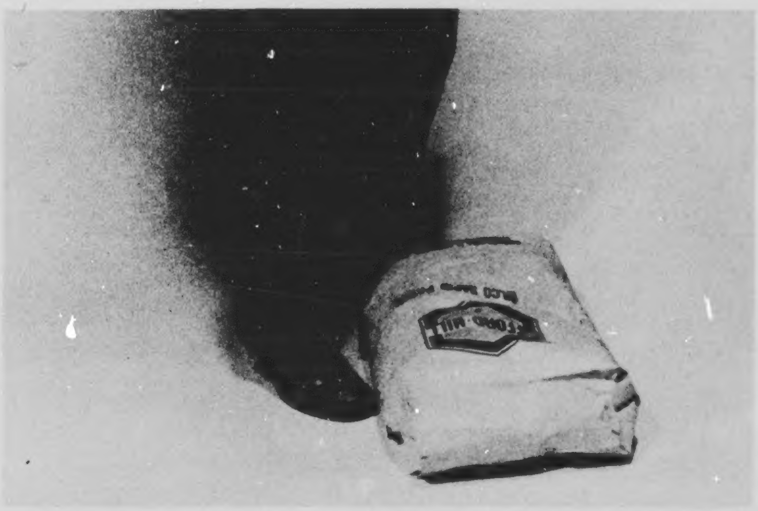
   A. A person

   B. Heavy object

II. Procedure

   A. Step up to object with feet apart; place one foot beside object and one behind (Figure 17)

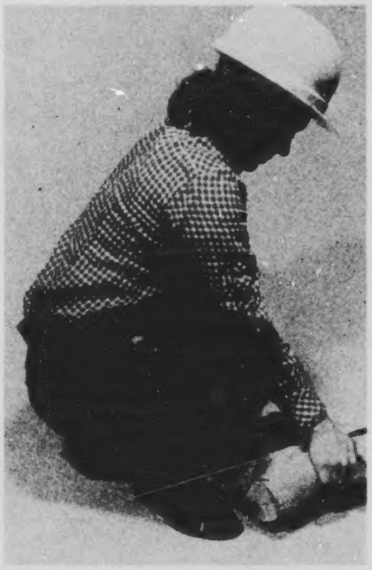
FIGURE 17



JOB SHEET #1

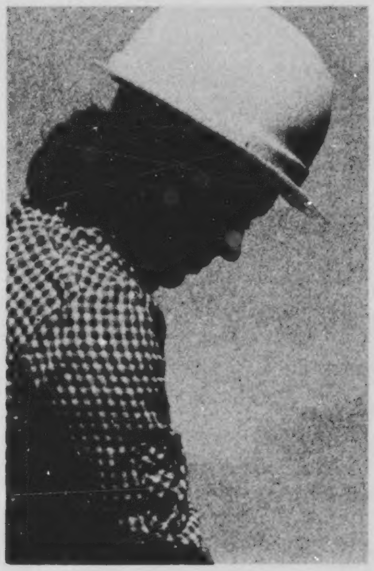
B. Keep back straight (Figure 18)

FIGURE 18



C. Tuck chin in (Figure 19)

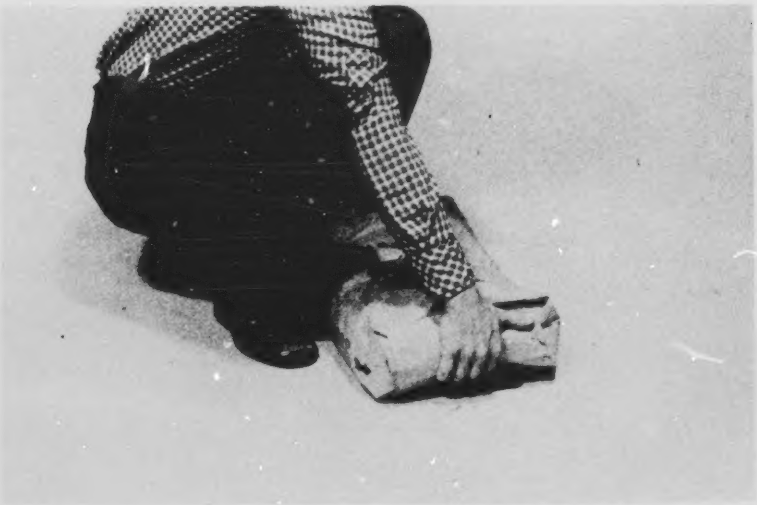
FIGURE 19



JOB SHEET #1

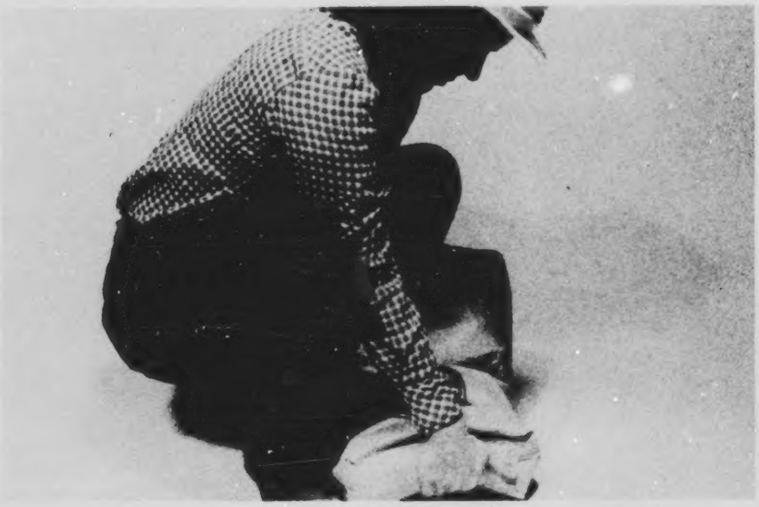
D. Grasp object with whole hand (Figure 20)

FIGURE 20



E. Tuck in elbows and arms and hold load close to body (Figure 21)

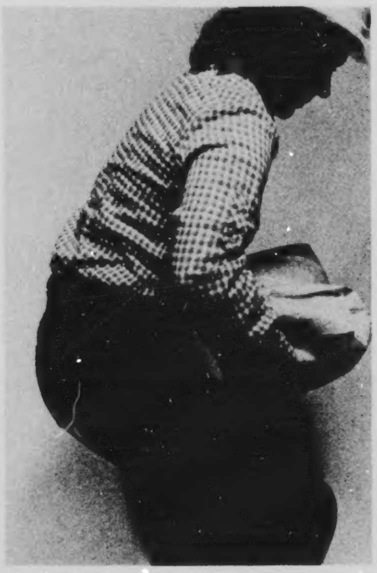
FIGURE 21



JOB SHEET #1

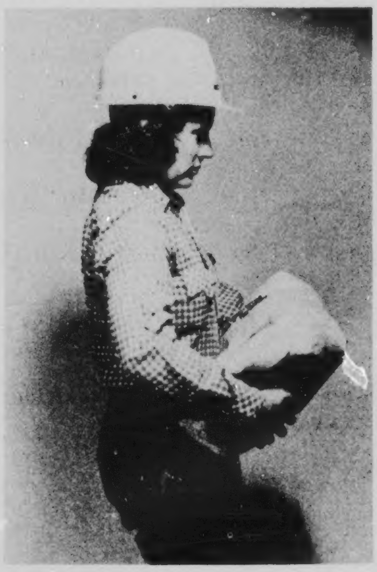
F. Keep body weight directly over feet (Figure 22)

FIGURE 22



G. Lift object (Figure 23)

FIGURE 23



SAFETY
UNIT II

JOB SHEET #2--TREAT FROSTBITE

I. Equipment, materials, and personnel

   A. "Victim" with frostbitten hands and feet

   B. Blankets and extra clothing

   C. Tepid water

   (NOTE: Water should be warm but not hot when poured over inner surface of forearm.)

   D. Sterile gauze

II. Procedure

   A. Do not allow victim to walk on frostbitten feet (or with frostbitten legs)

   B. Place frostbitten hands in victim's armpits or between legs

   C. Get victim to shelter

   D. Remove anything binding, and wet or frozen clothing

   E. Rewarm frostbitten parts by soaking them in tepid water

   (NOTE: It is best to warm the whole body, as in a bathtub. If water is not practical to use, wrap injured parts *gently* in sheet and blankets.)

   (CAUTION: Do not rub the frostbitten part. This causes tissue damage.)

   F. Handle frostbitten parts gently and protect them from further injury

   G. Place sterile gauze between frostbitten fingers and/or toes to keep them separated

   H. Elevate frostbitten parts

   EXAMPLES: With victim lying down, place pillows under feet; elevate hands on pillow across victim's middle.

   I. Give warm liquids

   (NOTE: Do not give alcohol.)

   I. Allow victim to sleep

SAFETY
UNIT II

JOB SHEET #3--GIVE MOUTH-TO-MOUTH RESUSCITATION

I. Equipment--Resuscitation doll

(NOTE: *Do not* practice on a breathing person.)

II. Procedure

A. Clear victim's air passage

1. Place victim flat on back (Figure 24)

(NOTE: If it is necessary to roll victim over, try to roll the victim over all at once, keeping back and neck straight to avoid making any possible spinal injury worse.)

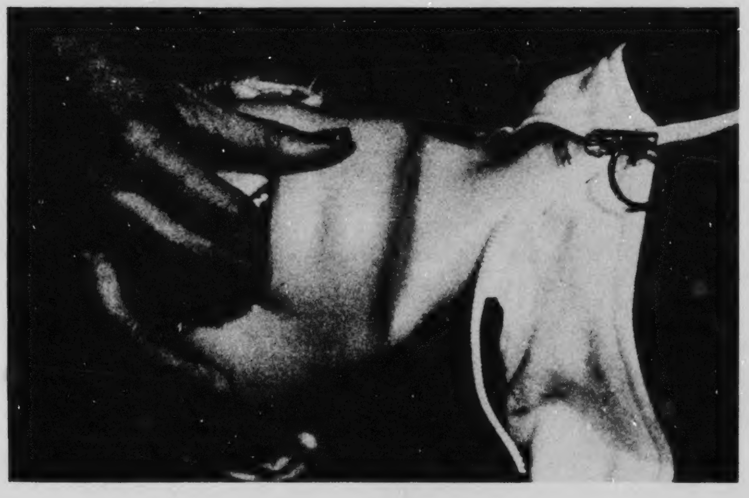
FIGURE 24

JOB SHEET #3

2. Remove all foreign objects from victim's mouth and throat (Figure 25)

   (NOTE: If there is an obstruction, carefully turn victim on side, tilt head down, and clean mouth out with your fingers. When obstruction is removed, carefully position victim onto back again.)

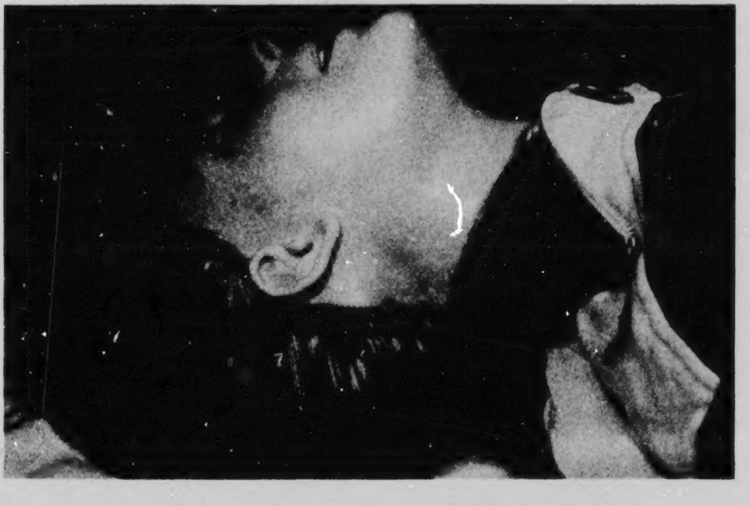
FIGURE 25



3. Kneel at the victim's side and lift up under the neck, tilting crown of head backwards (Figure 26)

   (NOTE: If possible, place a rolled piece of clothing under the victim's shoulders; this will help to secure the backward tilt of head.)

FIGURE 26

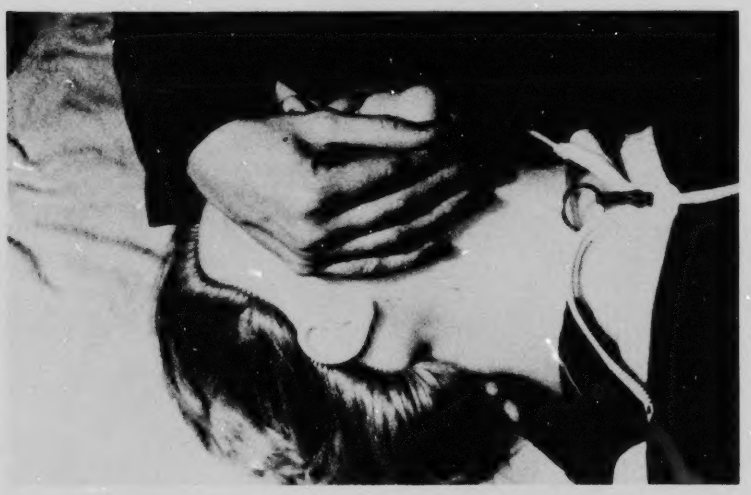


JOB SHEET #3

4. Pull the lower jaw so that the chin points straight up (Figure 27)

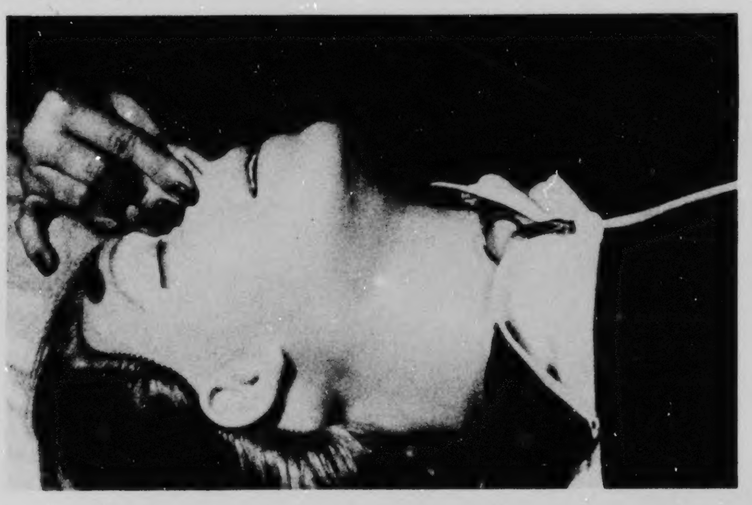
   (NOTE: This will pull the tongue forward and open the air passage.)

FIGURE 27



B. Pinch the nostrils shut while still lifting up under the victim's neck (Figure 28)

FIGURE 28

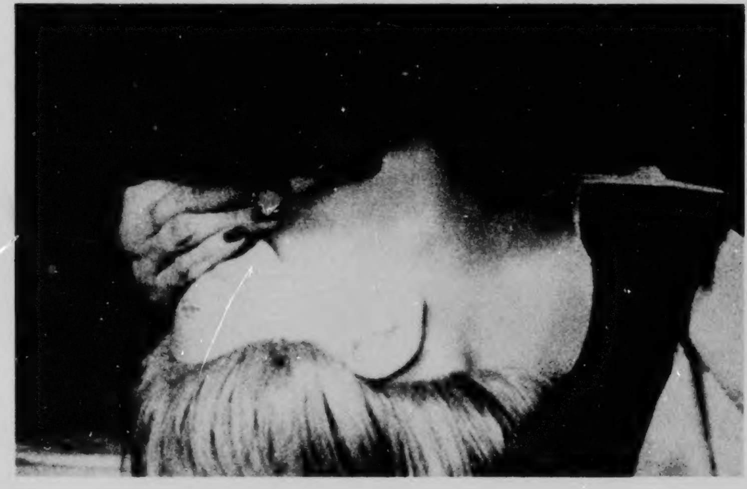


JOB SHEET #3

C. Inhale deeply, and while making an airtight seal with your mouth over the victim's mouth, breathe into victim's mouth until chest rises (Figure 29)

(CAUTION: Keep victim's chin extended at all times.)

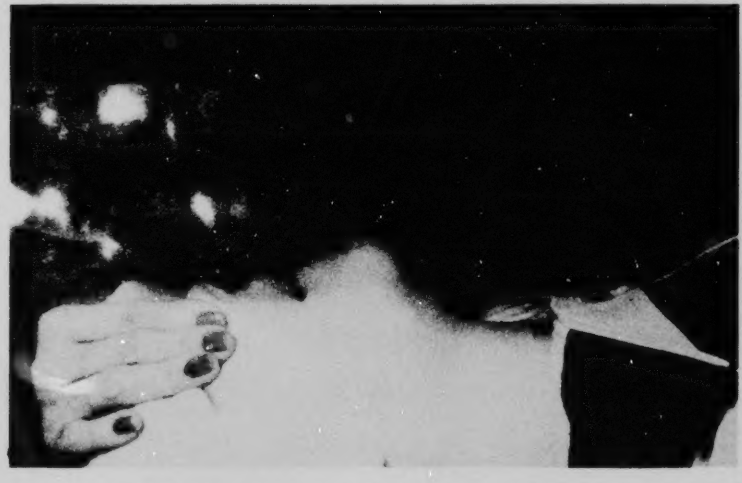
FIGURE 29



D. Remove your mouth from victim's mouth and listen for return flow of air (Figure 30)

(NOTE: Continue breathing, listening at rate of one breath per five seconds, or twelve breaths per minute, for an adult.)

FIGURE 30



E. Repeat steps C and D until victim is breathing on his or her own or until medical help takes over treatment

SAFETY
UNIT II

JOB SHEET #4--FLAG WITH A PADDLE

(NOTE: The paddle is the preferred signal for daytime flagging. A highly reflective paddle may also be used for nighttime flagging, especially since it is effective when wet.)

I. Equipment and materials

   A. One STOP/SLOW paddle, 24 inches across

   B. Reflective clothing

II. Procedure

   A. Stopping traffic (Figure 31)

      1. Stand in a safe position on shoulder or in barricaded area

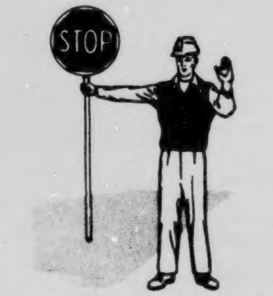
      2. Hold paddle in RIGHT hand

      3. Extend arm so that paddle is away from body and toward traffic lane

      4. Hold paddle plumb, with sign face fully visible to approaching drivers

      5. Raise free arm with palm toward driver

FIGURE 31



TO STOP TRAFFIC WITH A PADDLE

      6. Look driver in eye; maintain eye contact until driver comes to a full stop

      7. After first vehicle has been stopped, move to a conspicuous position near centerline in order to be readily seen by drivers approaching from rear

      8. Check for signal from other end of work zone

      (NOTE: *Make sure* it is safe to release your traffic. *Glance* at signal person from half-open position. NEVER TURN FULL BACK TO TRAFFIC.)

JOB SHEET #4

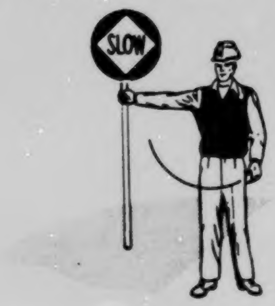
9. Remain in this position until you are ready to release traffic

(CAUTION: Never stand in the path of an approaching vehicle.)

B. Releasing traffic when it is safe to proceed (Figure 32)

1. Move to side of traffic lane and stand parallel to flow of traffic
2. Turn paddle to "SLOW" side
3. With free arm, motion traffic to proceed

FIGURE 32



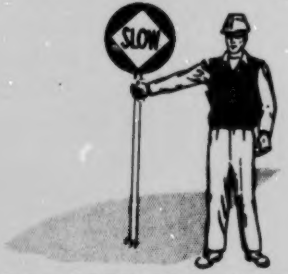
TO RELEASE TRAFFIC WITH A PADDLE

(NOTE: Always use slow motions. Rapid gestures may be seen as impatience or as a signal to hurry.)

C. Alerting or slowing traffic (Figure 33)

1. Stand to right of traffic lane
2. Show only "SLOW" face of paddle, holding it plumb, with sign face fully visible to approaching drivers
3. Wave traffic through with free hand, using a slow, regular motion

FIGURE 33



TO ALERT OR SLOW TRAFFIC
WITH A PADDLE

SAFETY
UNIT II

JOB SHEET #5--FLAG WITH A FLAG

(NOTE: Flags are to be used for daytime flagging only.)

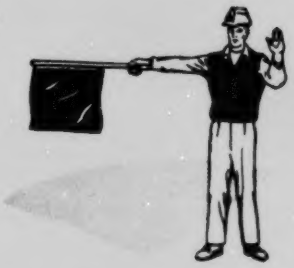
I. Equipment and materials

- A. One 24-inch-square red flag on a staff approximately 3 feet long
- B. Reflective clothing

II. Procedure (Figure 34)

- A. Stopping traffic
  1. Stand in safe position on shoulder or in barricaded area
  2. Hold flag in RIGHT hand
  3. Extend flag horizontally across traffic lane
  4. Raise free arm, with palm toward driver

FIGURE 34



TO STOP TRAFFIC

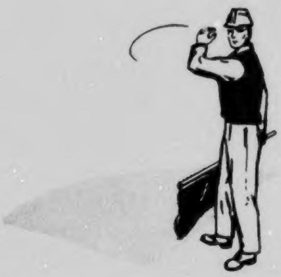
5. Look driver in eye; maintain eye contact until driver comes to a full stop
6. After first vehicle has been stopped, move to a conspicuous position near centerline in order to be readily seen by drivers approaching from rear

JOB SHEET #5

B. Releasing traffic when it is safe to proceed (Figure 35)

1. Move to side of traffic lane, and stand parallel to flow of traffic
2. Lower flag to your side
3. With free arm, motion traffic to proceed

FIGURE 35



TO RELEASE TRAFFIC WITH A FLAG

(NOTE: *Do not* wave traffic through with flag. Use slow motions. Rapid gestures may be seen as impatience or as a signal to hurry.)

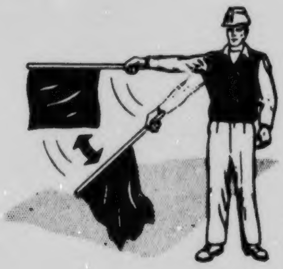
C. Alerting or slowing traffic (Figure 36)

(NOTE: Used when slowing traffic or funneling traffic into other lanes.)

1. Face traffic
2. Wave flag slowly up and down in sweeping motion

(NOTE: Keep flag at shoulder level; don't raise it above the horizontal.)

FIGURE 36



TO ALERT OR SLOW TRAFFIC WITH A FLAG

JOB SHEET #5

3. When vehicle has slowed, lower flag, and with free arm, motion driver to proceed

   (NOTE: Never wave traffic through with the flag.)

SAFETY
UNIT II

JOB SHEET #6--FLAG WITH A FLASHLIGHT

(NOTE: Workers should understand flagging signals for their own protection and for that of other workers and the public. All workers should be able to act as the flag person should the need arise.)

I. Equipment and materials

   A. Fluorescent gloves

   B. Light-colored clothing

   C. Flashlight with an 8-inch red wand

   (NOTE: This job sheet should be completed at night. Provide sufficient illumination at the flagging station. Amber-orange flashers should be placed near advance warning signs.)

II. Procedure

   A. Stopping traffic

      1. Stand in a safe position on shoulder or in barricaded area
      2. Hold flashlight in RIGHT hand
      3. Wave flashlight back and forth over traffic lane
      4. After first vehicle has stopped, move to a conspicuous position near centerline, so as to be readily seen by drivers approaching from rear

   B. Releasing traffic when it is safe to proceed

      1. Move to side of traffic lane, and stand parallel to flow of traffic
      2. Lower flashlight
      3. With free arm, motion driver to proceed

      (NOTE: *Do not* use the flashlight as a signal to proceed.)

   C. Alerting or slowing traffic

      1. Face traffic
      2. Wave flashlight back and forth over traffic lane
      3. When vehicle has slowed sufficiently, lower flashlight, and with free arm, motion the driver to proceed

      (NOTE: Use slow, sweeping gestures. Rapid gestures may be seen as impatience or as a signal to hurry.)

SAFETY
UNIT II

TEST

NAME ____ SCORE __________________

1. Match terms associated with safety to their correct definitions. Write the correct numbers in the blanks.

_____a. Capable of being easily ignited and burning with extreme rapidity

_____b. Capable of bursting into flames

_____c. Federal legislation designed to ensure safe and sanitary working conditions for employees

_____d. Immediate, life-threatening emergency characterized by extremely high body temperature and disturbance of sweating mechanism

_____e. Tissue damage due to freezing of tissue fluids

_____f. State or condition of being safe; freedom from danger, risk, or injury

_____g. Muscular pains and spasms due to loss of salt through sweating or to inadequate intake of salt

_____h. Angle at which traffic is diverted from regular lane into new lane

_____i. Fatigue, weakness, and sometimes collapse due to loss of body fluids through sweating and inadequate water intake

_____j. Liquid substance capable of dissolving or dispersing one or more other substances

_____k. Any suddenly occurring, unintentional event which causes injury or property damage

_____l. To divert traffic flow from one lane into another lane

_____m. To cause to cease burning

_____n. Person who directs a machine operator into position

1. Frostbite
2. Spotter
3. Heat exhaustion
4. Flammable
5. Safety
6. Channelize
7. Solvent
8. Accident
9. Heat cramps
10. Occupational Safety and Health Act (OSHA)
11. Combustible
12. Heat stroke
13. Taper
14. Extinguish

TEST

______o. Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained

______p. Sections of a signposted roadway preceding and following taper

______q. Something tending to explode

______r. Act of bringing one back to full consciousness

______s. Stored under pressure greater than the pressure of the atmosphere

15. Explosive
16. Tangent
17. Resuscitation
18. First aid
19. Pressurized

2. State five reasons for practicing job safety.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

3. Match colors of the safety color code to their correct applications. Write the correct numbers in the blanks. An answer may be used more than once.

______a. Designates caution and marks physical hazards

______b. Identifies emergency stop bars, stop buttons, and emergency electrical stop switches on machinery

______c. Designates safety starter buttons and parts of equipment that may cause electrical shock

______d. Identifies fire protection equipment and its location

______e. Designates dangerous parts of equipment which may cut, crush, shock, or otherwise injure

______f. Designates exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws

1. Federal safety green
2. Federal safety orange
3. Federal safety purple
4. Federal safety black and white (used individaully or in combination)
5. Federal safety red
6. Federal safety yellow

TEST

_____g. Designates radiation hazards

_____h. Designates traffic flow

_____i. Designates storage areas

_____j. Designates location of safety equipment

_____k. Identifies portable containers of flammable liquids

_____l. Designates waste containers for explosive or combustible materials

_____m. Designates housekeeping purposes

_____n. Designates caution against starting, using, or moving equipment while under repair, or against the use of defective equipment

_____o. Designates location of first-aid equipment

_____p. Identifies the starting point or power source of machinery

_____q. Designates danger

4. Select from the following list rules for general job safety. Write an "X" in the blank before each correct answer.

_____a. Report all accidents to supervisor, regardless of nature or severity

_____b. Keep work area clear of scraps and litter

_____c. Follow manufacturer's safety rules and limitations for all equipment

_____d. Ignore safety rules if they take too much time

_____e. Clean up any spilled liquids immediately

_____f. Keep all tools sharp, clean, and in safe working order

_____g. Repair defective tools, machines, or other equipment

_____h. Use correct, properly fitting wrenches on nuts and bolts

_____i. Be conscious of others' safety

TEST

______ j. Use traffic control devices only in heavy traffic conditions

______ k. Do not use compressed air to clean yourself or your clothing

______ l. Store oily rags and waste in open containers where they can get plenty of ventilation

______ m. Clean up any spilled liquids at end of work period

______ n. Report all defective tools, machines, or other equipment to supervisor

______ o. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it

______ p. Keep accurate records on the use of all tools

______ q. Disconnect power lock and tag out machines before performing maintenance

______ r. Retain guards and safety devices on all equipment

______ s. Know procedures governing both public traffic flow and equipment traffic flow on job site

______ t. Disconnect guards and safety equipment when making adjustments to defective equipment

______ u. Be sure others are at a safe distance when operating moving equipment

5. Select from the following list procedures used to maintain a clean and orderly work area. Write an "X" in the blank before each correct answer.

______ a. Clear work areas of debris and other hazards

______ b. Sweep all dust into one corner

______ c. Clean slippery substances from floor

______ d. Check in machinery and equipment to the shop foreman before leaving work area

______ e. Arrange machinery and equipment to permit safe, efficient work practices and ease in cleaning

______ f. Pour flammable substances down drain or toilet

______ g. Leave in work area materials and tools which may be used next day

______ h. Keep brooms, brushes, and other housekeeping equipment where they are readily available

______ i. Store materials and supplies in proper places

TEST

6. State five personal safety rules.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

7. Arrange in order procedures used to lift heavy objects correctly. Write a "1" before the first step, a "2" before the second step, and so on.

_____a. Tuck chin in

_____b. Keep body weight directly over feet

_____c. Lift with legs, not with the back

_____d. Step up to object with feet apart; place one foot beside object and one behind

_____e. Grasp object with whole hand

_____f. Keep back straight, nearly vertical

_____g. Hold load close to body

_____h. Tuck elbows and arms in

8. Select from the following list measures for the prevention of injuries from extreme cold. Write an "X" in the blank before each correct answer.

_____a. Take frequent, short rest periods

_____b. Drink alcohol to keep warm

_____c. Learn to recognize the symptoms of overexposure and frostbite

_____d. Limit exposure as much as possible

_____e. Work quickly for long periods

_____f. Do not bathe before exposure

_____g. Keep moving

_____h. Wear proper clothing

_____i. Smoke before exposure

_____j. Do not drink alcohol before exposure to cold

TEST

9. Select from the following list proper clothing for extreme cold. Write an "X" in the blank before each correct answer.

______a. Clean red longjohns with a flap in the back

______b. Wool-lined mittens or gloves covered with wind- and water-repellent material

______c. Tight boots

______d. Cotton or polyester windbreaker

______e. Face helmet and head and ear coverings

______f. Warm boots

______g. Two pairs of socks

______h. Outer clothing which will repel wind and moisture

______i. Thermal-type woolen underwear

10. Select from the following list symptoms of cold exposure. Write an "X" in the blank before each correct answer.

______a. Shivering

______b. Constriction in the throat

______c. Drowsiness

______d. Nervousness

______e. Marked muscular weakness

______f. Numbness

______g. Extreme thirst

______h. Low body temperature

______i. Redness of the eyes

11. Arrange in order procedures for treatment of cold exposure. Write a "1" before the first step, a "2" before the second step, and so on.

______a. Drink hot liquids

______b. Get to a warm room as quickly as possible

______c. Remove wet or frozen clothing and anything that is binding

______d. Carry out appropriate procedures as described for frostbite

______e. Rewarm by adding clothing, wrapping in a blanket, or by getting into a tub of water that is warm *but not hot* to the forearm

TEST

12. Select from the following list the symptoms of frostbite. Write an "X" in the blank before each correct answer.

_____a. Frostbitten area is bright pink

_____b. Victim has difficulty hearing

_____c. Skin becomes white, gray, or waxy yellow

_____d. Skin burns and itches

_____e. Area of frostbite swells and feels hard

_____f. Pain may occur, then let up

_____g. Activity is only slightly restricted

_____h. Blisters may form

_____i. Breathing is in quick, short breaths

_____j. Skin tingles, then becomes numb

13. Select from the following list treatments for frostbite. Write an "X" in the blank before each correct answer.

_____a. Put frostbitten part in hot water as soon as possible

_____b. Give artificial respiration if needed

_____c. Warm frostbitten part as soon as possible

_____d. Give alcohol

_____e. Protect frozen area from further injury

_____f. Bandage frozen area tightly

14. State five measures to take for prevention of heat stroke, heat cramps, and heat exhaustion.

a. ____

b. ____

c. ____

d. ____

e. ____

TEST

15. Write critical information about symptoms and treatment of heat stroke, heat cramps, and heat exhaustion. Write your answers in the blanks. Chart is continued on next page.

CONDITION	SYMPTOMS	TREATMENT
HEAT STROKE	Visual disturbances Headache, nausea b. ______________ body temperature Hot, flushed, c. ______________ skin Strong, rapid pulse Slow, deep breathing Offensive body odor Possible convulsions Possible loss of consciousness	a. ______________________________ Remove clothing, and sponge with cool (not cold) water or alcohol Use fans, air conditioners, or fan by hand to circulate air and promote cooling d. Provide continuous massage ______________ ______________________________ Give artificial respiration if needed Transport to medical care as soon as possible Do not give stimulants or alcohol Get victim to a cool place
HEAT CRAMPS	e. ______________________ pain Nausea, dizziness g. ______________________ skin Heavy sweating Muscular twitching Severe muscle cramps	f. __________________ with your hands on the cramped muscles, or gently massage them Give *sips* of salt water Do not give plain cold drinks Do not give stimulants or alcohol

TEST

CONDITION	SYMPTOMS	TREATMENT
HEAT EXHAUSTION	h. ____________ body temperature i. Pale, ________________ skin Heavy sweating Nausea, possible vomiting Weakness, tiredness k. Fast, ______________ pulse Possible fainting	Move victim out of the sun, preferably to an air-conditioned room Loosen clothing Fan j. Apply ______________ cloths Give *sips* of salt water Allow fluids as desired if victim is able to swallow l. Have victim lie down and ____________ ______________________________ Do not allow victim to return to work for several days Victim should avoid further exposure to abnormally warm temperatures

TEST

16. Select from the following list procedures for treating bee stings. Write an "X" in the blank before each correct answer.

_____a. Apply hot compresses for three minutes

_____b. Apply stimulating lotions, such as alcohol

_____c. Wash area with soap and water

_____d. Apply soothing lotions such as calamine

_____e Remove stinger and venom sac

_____f. Gently squeeze out venom

_____g. Apply cold compresses for three minutes

_____h. Take asprin for pain if needed

17. Select true statements about procedures for treating severe reactions to bee stings. Write an "X" in the blank before each correct answer.

_____a. If victim has a history of allergic reactions, take victim to hospital or physician immediately

_____b. Apply to the sting cold cloths or ice contained in a towel or plastic bag

_____c. Raise the affected part higher than the victim's heart

_____d. Give artificial respiration if needed

_____e. Get the victim up and walking as soon as possible

_____f. If sting is on arm or leg, tie a band above the sting (between sting and heart)

_____g. Remove band after one hour

_____h. Place the victim's head between his knees

_____i. Give aspirin for pain

18. Select from the following list the components of the fire triangle. Write an "X" in the blank before each correct answer.

_____a. Fire

_____b. Oxygen

_____c. Carbon dioxide (CO_2)

_____d. Fuel

_____e. Heat

_____f. Water

TEST

19. Match classes of fires to their correct descriptions. Write the correct numbers in the blanks.

_____a. Fires that occur with flammable liquids such as gasoline, oil, grease, paint, and thinners

_____b. Fires that occur in ordinary combustible materials such as wood, rags, and rubbish

_____c. Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring

_____d. Fires that occur with combustible metals such as iron or magnesium

1. Class A
2. Class B
3. Class C
4. Class D

20. Match types of fire extinguishers to the classes of fire for which each is used. Write the correct numbers in the blanks. A blank may have more than one correct number.

_____a. Used on class A fires *only*

_____b. Used on Class B and C fires

_____c. Used on Class A, B, and C fires

1. Pressurized water
2. Carbon dioxide (CO_2)
3. Special purpose dry chemical
4. Multipurpose dry chemical
5. Water pump tank

21. State three safety rules concerning flammable liquids.

a. ______________________________

b. ______________________________

c. ______________________________

22. State six rules for traveling equipment on public roads.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

TEST

23. Select from the following list signal procedures for a breakdown. Write an "X" in the blank before each correct answer.

______a. Turn on emergency flashers 200 feet before pulling off the road

______b. Pull off the road

______c. Line up flares along a taper forward and to the rear of the equipment

______d. Sound horn prior to parking

______e. Carry safety signal devices

______f. Place one signal 100 feet (40 paces) ahead of equipment

______g. Place one signal 200 feet (80 paces) to rear of equipment

______h. Place third signal as near as is practical to side of equipment near traffic

______i. Place one signal as near as is practical to the side of the equipment away from the traffic

24. Select from the following list rules for personal job site safety. Write an "X" in the blank before each correct answer.

______a. Keep alert at all times

______b. Modify safety rules for efficiency

______c. Break monotony with periods of horseplay

______d. Don't jump onto or from equipment

______e. Be sure you have adequate ventilation

______f. Replace mirrors regularly

______g. Never mount or dismount a moving vehicle

______h. Use handholds to mount equipment

______i. Leave equipment in gear when you dismount

______j. Look and listen for equipment defects

______k. Report at the end of the work period when you sense a defect

______l. Read safety manual thoroughly and follow suggested procedures

______m. Keep in mind that you are an operator of *heavy equipment* and act *responsibly*

TEST

25. Select from the following list procedures for traveling equipment on the job site. Write an "X" in the blank before each correct answer.

_____a. Never travel a machine on a job site, in a congested area, or around people without a spotter to guide you

_____b. Maintain safe distance from other vehicles

_____c. Move your equipment when you are ready

_____d. Give right-of-way to loaded equipment on haul roads and in pits

_____e. If you cannot see your area clearly from the operator's seat and have no spotter, dismount and examine for possible hazards

_____f. Signal a forward move with three blasts of horn

_____g. Signal a forward move with two blasts of horn

_____h. Signal a reverse move with four blasts of horn

_____i. Never move pipe or similar items over the heads of other workers

_____j. Be sure everyone is in the clear before and while backing, hooking up, or moving attachments

_____k. For efficiency, operate equipment as fast as possible

_____l. Maintain a ground speed consistent with ground conditions

_____m. Keep in gear at all times; never coast

_____n. Pass only when necessary; use caution

_____o. Use extreme caution when there is a rider on the fender

_____p. Watch for overhead electrical power lines

_____q. Watch for flags indicating buried pipes and power and gas lines

_____r. Do not operate within 5 feet of power lines

26. Select from the following list factors affecting traffic controls for maintenance operations. Write an "X" in the blank before each correct answer.

_____a. Pedestrian movement

_____b. Speed

_____c. Number of operators at work site

_____d. Frequency of turns

TEST

_____e. Type of operation

_____f. Width of traffic lane

_____g. Number of traffic control devices available

_____h. Maneuvering space

_____i. Volume of traffic

_____j. Duration of operation

_____k. Ratio of workers to pedestrians

_____l. Frequency of cross movement

27. Select from the following list rules for use of traffic control devices. Write an "X" in the blank before each correct answer.

_____a. Do not remove all signs and barricades when all work is finished

_____b. Install before maintenance operation gets underway

_____c. Maintain properly during operations

_____d. Keep signs and barricades free from visual obstructions

_____e. Perform sign and barricade installation in a responsible manner

_____f. When operations are performed in stages, install devices for the whole operation before work begins

_____g. If signs will be needed for next day's work, leave them up overnight

28. Select from the following list rules for proper placement of signs. Write an "X" in the blanks before each correct answer.

_____a. Never place signs in traffic lane

_____b. Place signs in traffic lane when appropriate

_____c. Place at a distance that allows operator adequate time to respond

_____d. Place strictly according to departmental regulations regardless of traffic conditions

_____e. Place on left side of street or roadway

_____f. Place on right side of street or roadway

TEST

______g. Always place on both sides of street or roadway

______h. Place at rear of equipment

______i. Place where they will convey messages most effectively according to highway design, highway alignment, and speed

______j. Place advance warning signals 1,200 feet in advance of work area at 300-foot intervals where open highway conditions prevail

______k. Place advance warning signals 1,500 feet in advance of work area at 500-foot intervals where open highway conditions prevail

29. Match channeling devices to their proper uses. Write the correct numbers in the blanks.

______a. Used to guide traffic along a regular channel

______b. Used to mark an unusual vehicle path

______c. Used at points of special hazard

______d. Used when traffic is maintained *through* area being repaired

______e. Used at points of closure

1. Portable flasher support
2. Type I and Type II barricades
3. Cones
4. Type III barricades
5. Drums

30. State the responsibilities of flag person.

a. ______________________________

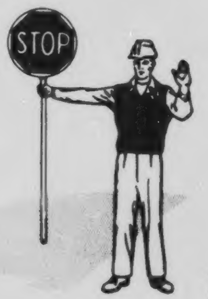
b. ______________________________

c. ______________________________

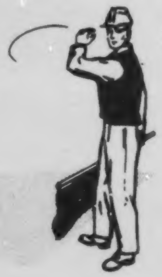
d. ______________________________

e. ______________________________

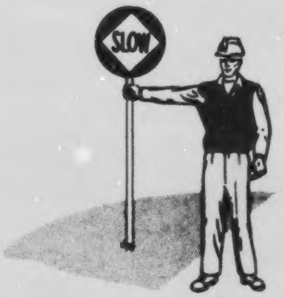
31. Identify flagging positions. Write in the appropriate blanks "stopping traffic," "releasing traffic," or "alerting or slowing traffic."



a. ____________________

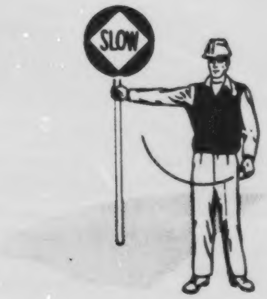


b. ____________________

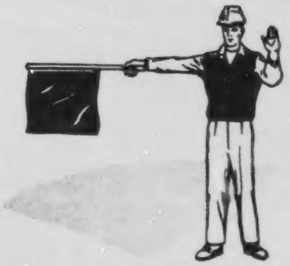


c. ____________________

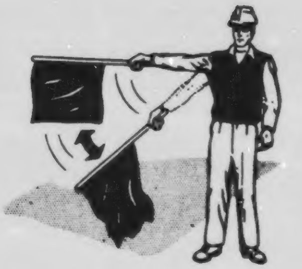
TEST



d. ____________________



e. ____________________



f. ____________________

32. State seven safety procedures for flag persons.

    a. ____

    b. ____

    c. ____

    d. ____

    e. ____

    f. ____

    g. ____

(NOTE: Test questions 33-39 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

33. Compile a survey of winter clothing needs.

34. Distinguish among symptoms and treatments for heat stroke, heat cramps, and heat exhaustion.

35. Analyze accident case studies.

36. Locate correct placement for emergency signals in the event of breakdown.

37. Construct a diagram of appropriate traffic control for a two-lane roadway.

38. Distinguish between correct and incorrect procedures for flag persons.

39. Demonstrate the ability to

    a. Show the correct way to lift.

    b. Treat frostbite.

    c. Give mouth-to-mouth resuscitation.

TEST

d. Flag with a paddle.

e. Flag with a flag.

f. Flag with a flashlight.

SAFETY
UNIT II

ANSWERS TO TEST

1. a. 4
   b. 11
   c. 10
   d. 12
   e. 1
   f. 5
   g. 9
   h. 13
   i. 3
   j. 7
   k. 8
   l. 6
   m. 14
   n. 2
   o. 18
   p. 16
   q. 15
   r. 17
   s. 19

2. Answer should include any five of the following
   a. Prevent physical harm to yourself and others
   b. Avoid loss of work hours
   c. Avoid possible loss of pay
   d. Lower cost to employer
   e. Prevent loss or damage of equipment or materials
   f. Lower insurance rates
   g. Prevent hardship on family
   h. Provide regular job schedules
   i. Prevent possible loss of job

3. a. 6
   b. 5
   c. 2
   d. 5
   e. 2
   f. 2
   g. 3
   h. 4
   i. 4
   j. 1
   k. 5
   l. 6
   m. 4
   n. 6
   o. 1
   p. 6
   q. 5

4. a, b, c, e, f, h, i, k, n, o, q, r, s, u

5. a, c, e, h, i

ANSWERS TO TEST

6. Answer should include any five of the following
    - a. Wear close-fitting clothing that is appropriate for the activity being performed
    - b. Confine long hair before operating equipment
    - c. Wear safety glasses, suitable hard hats, goggles, hearing protection, and respiratory equipment where required
    - d. Remove ties and fasten loose sleeves when working around machine tools or rotating equipment
    - e. Remove rings and other jewelry when working
    - f. Be alert and conduct yourself in a manner that will ensure safe practices
    - g. Use soap and water frequently to prevent skin disease
    - h. Do not jump onto or from moving equipment
    - i. Know location of first-aid equipment and fire extinguishers

7. a. 4 e. 5
   b. 8 f. 3
   c. 2 g. 7
   d. 1 h. 6

8. a, c, d, f, g, h, j

9. b, e, f, g, h, i

10. a, c, e, f, h

11. a. 4 d. 5
    b. 1 e. 3
    c. 2

12. c, e, f, h, j

13. b, c, e

ANSWERS TO TEST

14. Answer should include any five of the following
    a. Drink plenty of fluids
    b. Increase salt intake by taking salt tablets
    c. Do not overexert
    d. Wear lightweight clothing
    e. Keep head covered and face shaded
    f. Take frequent, short work breaks
    g. Rest in shade whenever possible

15. a. Cool the body immediately
    b. High
    c. Dry
    d. Toward the heart
    e. Abdominal
    f. Exert firm pressure
    g. Pale
    h. Approximately normal
    i. Clammy
    j. Cool, wet
    k. Weak
    l. Raise feet 8" -12"

16. c, d, e, g, h

17. a, b, d, f, i

18. b, d, e

ANSWERS TO TEST

19. a. 2
    b. 1
    c. 3
    d. 4

20. a. 1, 5
    b. 2, 3
    c. 4

21. Answer should include any three of the following
    a. Know the location and use of fire extinguishers for flammable liquids
    b. Store all flammable liquids in approved safety containers
    c. Use only approved cleaning solvents to clean parts
    d. Do not operate an engine that is leaking gasoline
    e. Change oil-soaked or gasoline-soaked clothing immediately
    f. Do not fuel a running engine

22. Answer should include any six of the following
    a. Drive slowly
    b. Know your stopping distance
    c. Allow extra time to enter traffic
    d. Stay in the extreme right lane or on shoulder
    e. Travel with lights on
    f. Use proper warning signs and flags
    g. Secure all attachments and loose gear
    h. Turn cautiously; allow for extensions or attachments and for structure clearance
    i. Know and obey state and local laws

ANSWERS TO TEST

23. b, e, f, h

24. a, d, e, g, h, j, l, m

25. a, b, d, e, g, i, j, l, m, n, p, q

26. a, b, d, e, h, i, j, l

27. b, c, d, e

28. b, c, f, i, k

29. a. 3
    b. 5
    c. 1
    d. 2
    e. 4

30. a. Protecting public, other workers, and self
    b. Promoting good public relations
    c. Stopping or slowing traffic
    d. Releasing traffic when it is safe to proceed
    e. Alerting drivers to traffic conditions

31. a. Stopping traffic
    b. Releasing traffic
    c. Alerting or slowing traffic
    d. Releasing traffic
    e. Stopping traffic
    f. Alerting or slowing traffic

ANSWERS TO TEST

32. Answer should include any seven of the following

    a. Wear a hard hat and a reflective vest

    b. Stand where you can be seen by oncoming traffic for 500 feet or more

    c. Stand 100 - 200 feet from work area

    d. Stand in safe position on shoulder, never in path of approaching vehicles

    e. Stand sideways to traffic

    f. Use either a STOP/SLOW paddle or a 24-inch-square red flag for daylight flagging

    g. For night flagging, use a flashlight with an 8-inch red wand

    h. Always stand alone; never mingle with maintenance crew

    i. Remain at your station until properly relieved or until job is ended

    j. When communicating with other flaggers, use verbal signals or hand signals which will not be mistaken for flagging signals

    k. Remove all traffic control signs when work has ended

33. Evaluated to the satisfaction of the instructor

34. Evaluated to the satisfaction of the instructor

35. Evaluated to the satisfaction of the instructor

36. Evaluated to the satisfaction of the instructor

37. Evaluated to the satisfaction of the instructor

38. Evaluated to the satisfaction of the instructor

39. Performance skills evaluated to the satisfaction of the instructor

BASIC MATH
UNIT III

UNIT OBJECTIVE

After completing this unit, the student should be able to solve basic math problems. This knowledge will be shown by completing assignment sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with basic math to their correct definitions.
2. Match symbols used in math problems to their correct names.
3. Solve addition problems.
4. Solve subtraction problems.
5. Solve multiplication problems.
6. Solve division problems.
7. Distinguish among types of fractions.
8. Convert mixed numbers to improper fractions.
9. Reduce fractions to lowest terms.
10. Add fractions.
11. Find lowest common denominators.
12. Subtract fractions.
13. Multiply fractions.
14. Divide fractions.
15. Match numerals in decimal numbers to their correct place value names.
16. Convert fractions to decimals.
17. Add decimals.
18. Subtract decimals.
19. Multiply decimals.
20. Divide decimals by decimals.
21. Divide whole numbers by decimals.

OBJECTIVE SHEET

22. Convert fractions to decimals and percentages.
23. Convert percentages to fractions and decimals.
24. Solve percentage problems.
25. Write common fractional and decimal equivalents.
26. Match standard measures to their equivalents.
27. Write the basic formulas for surface area, area of a triangle, and volume.
28. Solve mix ratio problems.
29. Solve slope ratio problems.
30. Solve problems using measure and volume.

BASIC MATH
UNIT III

SUGGESTED ACTIVITIES

I. Suggested activities

A. Order materials to supplement unit.

1. Films

a. *Fractions--Some Operations with Fractions.* Color, 16 mm, 15 minutes, Gilbert Altschul Productions, Inc., 1974. Available from University of Arizona, Division of Media and Instructional Services, Tuscon, Arizona 85706. Phone (602) 626-3282.

b. *How to Change Fractions (Second Edition.)* Color, 16 mm, 11 minutes, Johnson-Hunt Productions, 1968.

c. *Decimal Fractions (Second Edition).* Color, 16 mm, 10 minutes. Johnson-Hunt Productions, 1967.

(NOTE: Films **b** and **c** are available from Idaho State University, Audio Visual Services, Campus Box 8064, Pocatello, Idaho 83209. Phone [208] 864-3212.)

d. *Brushing up on Multiplication.* Color, 16 mm, 11 minutes, Coronet Instructional Films, 1961.

e. *Brushing up on Division.* Color, 16 mm, 11 minutes, Coronet Instructional Films, 1961.

(NOTE: Films **d** and **e** are available from Oklahoma State University Film Library, Stillwater, Oklahoma 74078. Phone [405] 624-7216.)

f. *Ratio and Proportion in Mathematics.* Black and white, 16 mm, 11 minutes, Coronet Division of Esquire, Inc., 1961. Available from University of Kansas, Audio Visual Center, 746 Massachusetts Street, Lawrence, Kansas 66044. Phone (913) 864-3352.

2. Filmstrip/cassete program--*Problem Solving in Mathematics.* Includes 10 filmstrips. 10 cassettes, student workbook duplicating master, class record sheets, library kit, and teacher's guide; Pathescope Educational Media, 1982. Available from Pathescope Educational Media Communications Park, Box 6000, Mount Kisco, New York 10549. Phone (800) 431-1242.

(NOTE: This program is set up in ascending order of difficulty and covers whole numbers, fractions, decimals, percentages, and combined computational skills. Mature characters and situations are featured. Many mathematics filmstrip/cassette programs are available from this company.)

SUGGESTED ACTIVITIES

B. Make transparency.

C. Provide students with objective sheet.

D. Provide students with information and assignment sheets.

E. Discuss unit and specific objectives.

F. Discuss information and assignment sheets.

G. Use chalkboard to demonstrate steps in solving problems.

H. Provide students with chart on decimal equivalents so that they may complete objectives on solving decimal problems.

I. If your department of transportation advocates the metric system, provide students with conversion charts and formulas.

J. Instruct students to round off answers to the nearest hundredth (two decimal places) except where noted.

(NOTE: Electronic calculators may provide answers slightly different from those obtained with an adding machine or with pencil and paper. Conversion methods used may also cause answers to vary slightly.)

K. Give test.

(NOTE: It is recommended that this test be given in parts, such as the math processes, fractions, and decimals.)

II. Instructional materials

A. Objective sheet

B. Suggested activities

C. Information sheet

D. Transparency Master: TM #1--Math Function Terms

E. Assignment sheets

1. Assignment Sheet #1--Solve Addition Problems
2. Assignment Sheet #2--Solve Subtraction Problems
3. Assignment Sheet #3--Solve Multiplication Problems
4. Assignment Sheet #4--Solve Division Problems
5. Assignment Sheet #5--Convert Fractions

SUGGESTED ACTIVITIES

6. Assignment Sheet #6--Reduce Fractions to Lowest Terms
7. Assignment Sheet #7--Find Lowest Common Denominators
8. Assignment Sheet #8--Add, Subtract, Multiply, and Divide Fractions
9. Assignment Sheet #9--Convert Fractions to Decimals
10. Assignment Sheet #10--Add, Subtract, Multiply, and Divide Decimals
11. Assignment Sheet #11--Convert Fractions to Decimals and Percentages; Convert Percentages to Fractions and Decimals
12. Assignment Sheet #12--Solve Mix Ratio Problems
13. Assignment Sheet #13--Solve Slope Ratio Problems
14. Assignment Sheet #14--Solve Problems Using Measure and Volume

F. Answers to assignment sheets

G. Test

H. Answers to test

III. Unit references

A. Gossage, Loyce G., and Milton Briggs. *Basic Mathematics Review.* Cincinnati, Ohio: South-Western Publishing Co., 1969.

B. Hendrix, Laborn J., "Bud." *Millwright Instructional Materials.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/ Curriculum and Instructional Materials Center and Associated General Contractors of America, 1980.

C. Morrison, Phyllis. *Basic Math Skills.* New York: McGraw-Hill Book Company, 1972.

BASIC MATH
UNIT III

INFORMATION SHEET

I. Terms and definitions (Transparency #1)

A. Problem--Mathematical proposition

B. Calculate--To solve by mathematical process

C. Addition--Combining of two or more numbers

EXAMPLE: 18 + 3 = 21

D. Subtraction--Finding the difference between two numbers

EXAMPLE: 21 − 3 = 18

E. Multiplication--Abbreviated process of adding a number to itself a specified number of times

EXAMPLE: 6 x 3 = 18 (6 + 6 + 6 = 18)

F. Product--Answer to a multiplication problem

EXAMPLE: 6 x 3 = 18 18 is the product

G. Division--Opposite operation of multiplication

EXAMPLE: 16 ÷ 2 = 8

H. Dividend--Number being divided

EXAMPLE: 16 ÷ 2 = 8 16 is the dividend

I. Divisor--Number by which you divide

EXAMPLE: 16 ÷ 2 = 8 2 is the divisor

J. Quotient--Answer to a division problem

EXAMPLE: 16 ÷ 2 = 8 8 is the quotient

K. Digit--Any one of the ten symbols, 0 to 9, by which all numbers may be expressed

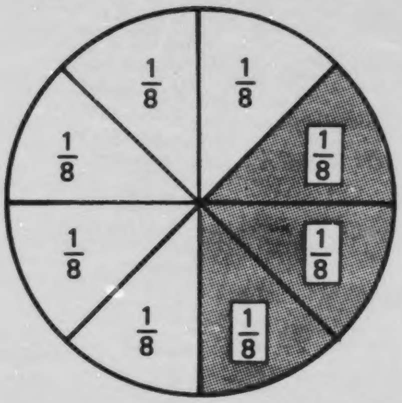
L. Integer--Positive or negative whole number

M. Unit--First integer, equal to 1

INFORMATION SHEET

N. Fraction--Part of a whole; represents one or more equal parts of a unit

EXAMPLE: If the unit is divided into eight equal parts, then each part is one-eighth (1/8) of the unit; the fraction three-eighths (3/8) means three of the parts, as shown in the shaded portion of the figure below.



O. Numerator--Top number of the fraction; tells how many equal parts of the whole are being considered

EXAMPLE: 3/8 3 is the numerator

P. Denominator--Bottom number of fraction; tells into how many equal parts the whole is divided

EXAMPLE: 3/8 8 is the denominator

Q. Decimals--Fractions based on the number 10; not written as common fractions

EXAMPLES:

$$\frac{1}{10} = 0.1$$

$$\frac{6}{100} = 0.06$$

$$\frac{3}{1000} = 0.003$$

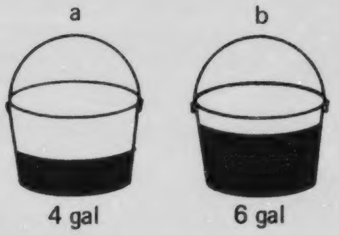
R. Percent--"Per hundred"; division into 100 equal parts; another way of expressing a fraction whose denominator is 100

EXAMPLE: 3% = 3 per hundred = 0.03

INFORMATION SHEET

S. Ratio--Comparison of one quantity with another like quantity or value using the : symbol or division bar

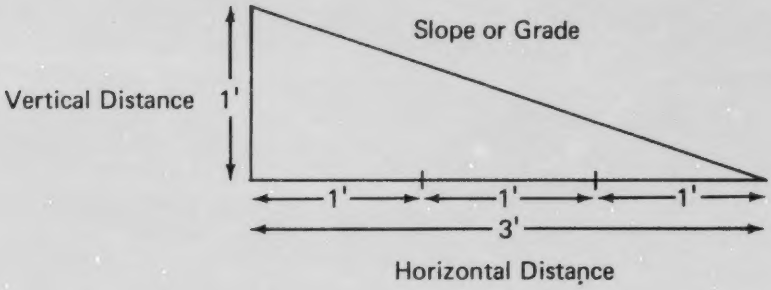
EXAMPLE: a:b or $\frac{a}{b}$


a
b
4 gal
6 gal

The ratio, or relationship of the material in bucket **a** to the material in bucket **b** is 4:6 or 4/6, stated "four to six."

T. Slope ratio--Describes the relationship between the horizontal distance and the vertical distance of a slope, expressed in feet

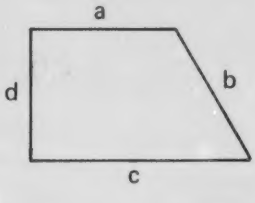
EXAMPLE: 3:1 means that for every foot of vertical distance, there are 3 feet of horizontal distance; or that the slope extends 3 feet across for every 1 foot of rise


Slope or Grade
Vertical Distance
1'
1'
1'
1'
3'
Horizontal Distance

U. Caret (‸) --Mark made to indicate where something is to be inserted

V. Perimeter--Outer limits or boundary of a space

EXAMPLE:

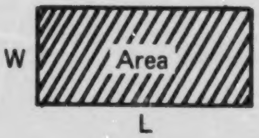


a + b + c + d = Perimeter

INFORMATION SHEET

W. Area--Measure of a flat surface having length and width; expressed in square units

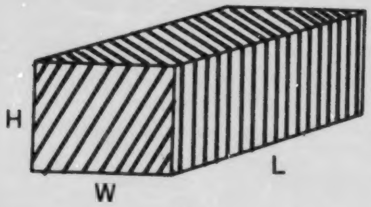
EXAMPLE:



W x L = Area in sq units

X. Volume--Space occupied by a body having length, height, and width; expressed in cubic units

EXAMPLE:



L x H x W = Volume in cu units

INFORMATION SHEET

II. Symbols used in math problems

Name of Symbol	Symbol(s)
A. Addition	+
B. Subtraction	—
C. Division	÷ $\overline{)}$
D. Multiplication	×
E. Equal	=
F. Decimal	.
G. Percent	%
H. Caret	∧
I. Ratio	:

III. Addition (Assignment Sheet #1)

A. Write units under units, tens under tens, and so on

B. Begin adding the far right column

C. If sum of any column is ten or more, write last figure and carry other figure

EXAMPLE:

$$\begin{array}{r} 1420 \\ 15 \\ +\ 123 \\ \hline 1558 \end{array} \qquad \begin{array}{r} 1 \\ 1352 \\ 17 \\ +\ 260 \\ \hline 1629 \end{array} \xleftarrow{\text{carried figure}}$$

IV. Subtraction (Assignment Sheet #2)

A. Write units under units, tens under tens, and so on

B. When subtracting, bottom figure almost always will be smaller than top figure

C. Begin with the first column on the far right, and move to the left

EXAMPLE:

$$\begin{array}{r} 784 \\ -\ 431 \\ \hline 353 \end{array}$$

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D. Check subtraction by adding the answer and the number just above it

(NOTE: The sum must be the same as the top number in the problem for the answer to be correct.)

EXAMPLE:

$$\begin{array}{lr} \text{Problem} & 634 \leftarrow \\ & -418 \\ \hline & 216 \\ \\ \text{Check} & 418 \\ & +216 \\ \hline & 634 \leftarrow \end{array}$$

E. When digits in the bottom figure are larger than the corresponding digits in the top figure, it is necessary to "borrow" one unit from the next column of the top number

EXAMPLE:

$$\begin{array}{r} 723 \\ -254 \\ \hline 469 \end{array} \qquad \begin{array}{r} \overset{6}{\cancel{7}}\overset{11}{\cancel{2}}\overset{13}{\cancel{3}} \\ -254 \\ \hline 469 \end{array} \qquad \begin{array}{r} 13-4=9 \\ 11-5=6 \\ 6-2=4 \end{array}$$

You cannot subtract 4 from 3 because 4 is greater than 3. Therefore, you must borrow 1 ten or 10 units from the ten's column and add this to the 3 units, giving you a total of 13 units. Repeat this process when subracting the 5, borrowing 100 from the hundreds column.)

V. Multiplication (Assignment Sheet #3)

A. Write the larger factor (multiplicand) above the smaller factor (multiplier)

(NOTE: Write units under units, tens under tens, and so on.)

B. If multiplier has only one figure, multiply this figure by each number in multiplicand, starting from right and working in order to the left

1. Multiply unit figure of top factor by multiplier

2. Write the results and carry over the tens

EXAMPLE:

$$\begin{array}{rl} 1 & \longleftarrow \text{Carried number} \\ 53 & \\ \times 4 & \\ \hline 2 & \end{array}$$

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3. Multiply the second figure of multiplicand by the multiplier and add carried number

EXAMPLE:

$$\begin{array}{rl} 1 & \longleftarrow \text{Carried number} \\ 53 & \\ \times 4 & \\ \hline 212 & \end{array}$$

4. Continue working to the left until all figures in multiplicand have been multiplied

C. If multiplier has more than one figure, find partial products first

1. Multiply each number in multiplicand by first figure on the far right of multiplier; record partial product

EXAMPLE:

$$\begin{array}{rl} 174 & \\ \times 42 & \\ \hline 348 & \text{Partial product} \end{array}$$

2. Multiply each number in multiplicand by second figure from right in multiplier; record partial product

EXAMPLE:

$$\begin{array}{rl} 174 & \\ \times 42 & \\ \hline 348 & \text{Partial product} \\ 696 & \text{Partial product} \end{array}$$

3. Continue as above until each figure in the multiplier has multiplied the top figures

4. Add the partial products

EXAMPLE:

$$\begin{array}{rl} 174 & \\ \times 42 & \\ \hline 348 & \\ 696 & \\ \hline 7{,}308 & \text{Product} \end{array}$$

INFORMATION SHEET

VI. Division (Assignment Sheet #4)

A. Write inside the frame the number to be divided (dividend); write the number you are dividing by (divisor) on the outside of frame

EXAMPLE: $1974 \div 6$ $\quad 6\overline{)1974}$

B. Determine how many times number on outside will go into the first number on the inside; if it will not go into the first one, determine how many times it will go into first two numbers and write this figure on top of frame above the right digit of the number it went into

EXAMPLE: $1974 \div 6$

$$\begin{array}{r} 3 \\ 6\overline{)1974} \end{array}$$

C. Multiply number on outside of frame by number on top; write results under the figures the outside number went into, and subtract these figures

EXAMPLE: $1974 \div 6$

$$\begin{array}{r} 3 \\ 6\overline{)1974} \\ \underline{18} \\ 1 \end{array}$$

D. Bring down the next figure; determine how many times the number on outside of frame will go into bottom figure, and write it above the figure that was brought down

EXAMPLE: $1974 \div 6$

$$\begin{array}{r} 32 \\ 6\overline{)1974} \\ \underline{18} \\ 17 \end{array}$$

E. Multiply number on outside of frame by the last number you wrote on top; write results you wrote on top; write results under the figures the outside number went into, and subtract these figures

EXAMPLE: $1974 \div 6$

$$\begin{array}{r} 32 \\ 6\overline{)1974} \\ \underline{18} \\ 17 \\ \underline{12} \\ 5 \end{array}$$

INFORMATION SHEET

F. Bring down next figure; determine how many times number on outside of frame will go into it and write it above figure that was brought down; multiply times the number on outside and write the results

EXAMPLE: 1974 ÷ 6

$$\begin{array}{r} 329 \\ 6\,\overline{)\,1974} \\ \underline{18} \\ 17 \\ \underline{12} \\ 54 \\ \underline{54} \end{array}$$

G. Continue the same process until all numbers in the dividend are used

H. Check answer by multiplying the quotient and divisor

EXAMPLE: 1974 ÷ 6

$$\begin{array}{r} 329 \\ 6\,\overline{)\,1974} \\ \underline{18} \\ 17 \\ \underline{12} \\ 54 \\ \underline{54} \end{array} \qquad \text{Check} \quad \begin{array}{r} 329 \\ \underline{\times\ 6} \\ 1974 \end{array}$$

VII. Types of fractions (Assignment Sheet #5)

A. Proper--Top number of fraction (numerator) is smaller than the bottom number of fraction (denominator)

EXAMPLE: $\frac{8}{9}$

B. Improper--Top number of fraction (numerator) is larger than, or equal to, the bottom number of fraction (denominator)

EXAMPLES: $\frac{8}{6}$ $\frac{7}{7}$

C. Mixed--Contains a whole number and a fraction

EXAMPLES: $9\frac{1}{2}$ $4\frac{2}{3}$ $1\frac{7}{8}$

VIII. Converting mixed numbers to improper fractions (Assignment Sheet #5)

A. Multiply the denominator of the fraction by the whole number

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B. Add the numerator of the fraction

(NOTE: This number becomes the numerator.)

EXAMPLES:

$$4\frac{3}{5} = \frac{(5 \times 4) + 3}{5}$$

$$= \frac{20 + 3}{5}$$

$$= \frac{23}{5}$$

$$7\frac{1}{2} = \frac{(2 \times 7) + 1}{2}$$

$$= \frac{14 + 1}{2}$$

$$= \frac{15}{2}$$

IX. Reducing fractions to lowest terms--Divide the numerator and denominator by a whole number that will go into each of them evenly (Assignment Sheet #6)

EXAMPLE:

$$\frac{4}{6} = \frac{4}{6} \div \frac{2}{2}$$

$$= \frac{2}{3}$$

4/6 is not reduced to lowest terms because both the numerator (4) and the denominator (6) can be divided by 2. 2/3 is reduced to lowest terms because both the numerator (2) and the denominator (3) cannot be divided by the same number.

X. Adding fractions (Assignment Sheet #8)

A. Common

(NOTE: Common fractions are sometimes called *like* fractions; they share the same denominator.)

1. Add the numerators
2. Place over common denominator

EXAMPLE: $\frac{1}{4} + \frac{2}{4} = \frac{3}{4}$

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3. Reduce to lowest terms

B. Uncommon fractions

(NOTE: Uncommon fractions are sometimes called *unlike* fractions; they have different denominators.)

1. Change fractions so that they have a common denominator

   (NOTE: The easiest way to find a common denominator is to multiply the denominators together and then convert the numerators. However, sometimes this method overlooks the *lowest* common denominator; and the fractions will have to be reduced.)

2. Add as common fractions

   EXAMPLE:

$$\frac{1}{3}+\frac{2}{5}=\left(\frac{1}{3}\times\frac{5}{5}\right)+\left(\frac{2}{5}\times\frac{3}{3}\right)$$

$$=\frac{5}{15}+\frac{6}{15}$$

$$=\frac{11}{15}$$

3. Reduce to lowest terms

C. Mixed numbers

1. Add whole numbers

2. Add fractions

INFORMATION SHEET

3. Combine these two answers

EXAMPLES:

$$3\frac{1}{7} + 7\frac{2}{7} = (3 + 7) + \left(\frac{1}{7} + \frac{2}{7}\right)$$

$$= 10 + \frac{3}{7}$$

$$= 10\frac{3}{7}$$

$$4\frac{2}{3} + 1\frac{5}{6} = (4 + 1) + \left(\frac{2}{3} + \frac{5}{6}\right)$$

$$= 5 + \left(\frac{4}{6} + \frac{5}{6}\right)$$

$$= 5 + \frac{9}{6}$$

$$= 5 + 1\frac{3}{6}$$

$$= 5 + 1\frac{1}{2}$$

$$= 6\frac{1}{2}$$

4. Reduce to lowest terms

XI. Lowest common denominators (Assignment Sheet #7)

(NOTE: The lowest common denominator [LCD] of two or more fractions is the lowest number that can be divided evenly by the denominators of each fraction.)

A. Change fractions to equivalent fractions with the same denominator

1. Raise a fraction to one with a higher denominator by multiplying both the numerator and denominator by the same number

(NOTE: Multiplying both terms of a fraction by the same number is the same as multiplying them by the number 1 and does not change the value of the fraction.)

EXAMPLE:

$$\frac{3}{4} \text{ and } \frac{1}{8} = \left(\frac{3}{4} \times \frac{2}{2}\right) \text{ and } \frac{1}{8}$$

$$= \frac{6}{8} \text{ and } \frac{1}{8}$$

INFORMATION SHEET

2. Reduce a fraction to one with a lower denominator by dividing both the numerator and denominator by the same number

   (NOTE: Dividing both terms of a fraction by the same number is the same as dividing them by the number 1 and does not change the value of the fraction.)

   EXAMPLE: $\frac{16}{32}$ and $\frac{5}{16} = \left(\frac{16}{32} \div \frac{2}{2}\right)$ and $\frac{5}{16}$

   $= \frac{8}{16}$ and $\frac{5}{16}$

B. Reduce fractions to lowest terms that still have a common denominator

   EXAMPLES: For 3/10 and 1/3, some common denominators are 30, 60, and 90. Thirty is the lowest number that can be divided evenly by 10 and 3.

   For 5/12 and 3/8 and 2/9, some common denominators are 72 and 144. The lowest common denominator is 72, the lowest number that can be divided evenly by 12, 8, and 9.

XII. Subtracting fractions (Assignment Sheet #8)

A. Common fractions

1. Subtract the numerators
2. Place over denominator
3. Reduce to lowest terms

EXAMPLE: $\frac{7}{10} - \frac{1}{10} = \frac{6}{10}$

$= \frac{3}{5}$

B. Uncommon fractions

1. Change fractions to equivalent fractions with common denominator
2. Subtract the numerators
3. Place numerators over common denominator
4. Reduce to lowest terms

EXAMPLE: $\frac{2}{3} - \frac{1}{2} = \frac{4}{6} - \frac{3}{6}$

$= \frac{1}{6}$

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C. Mixed numbers

1. Change mixed numbers to improper fractions
2. Change improper fractions to common fractions if necessary
3. Subtract the fractions
4. Reduce answer if possible

EXAMPLE:

$$5\frac{1}{3} - 3\frac{1}{2} = \frac{16}{3} - \frac{7}{2}$$

$$= \frac{32}{6} - \frac{21}{6}$$

$$= \frac{11}{6}$$

$$= 1\frac{5}{6}$$

XIII. Multiplying fractions (Assignment Sheet #8)

A. Multiply the numerators and denominators separately

B. Write the product of the numerator over the product of the denominator

C. Reduce to lowest terms

EXAMPLES:

$$\frac{2}{3} \times \frac{1}{2} = \frac{2 \times 1}{3 \times 2}$$

$$= \frac{2}{6}$$

$$= \frac{2}{6} \div \frac{2}{2}$$

$$= \frac{1}{3}$$

$$1\frac{1}{4} \times \frac{1}{2} = \frac{5}{4} \times \frac{1}{2}$$

$$= \frac{5 \times 1}{4 \times 2}$$

$$= \frac{5}{8}$$

(NOTE: The mixed number was changed to an improper fraction before multiplying.)

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XIV. Dividing fractions (Assignment Sheet #8)

A. Invert the divisor

B. Multiply the numerators and denominators separately

C. Write the product of the numerator over the product of the denominator

D. Reduce to lowest terms

EXAMPLES:

$$\frac{7}{8} \div \frac{1}{4} = \frac{7}{8} \times \frac{4}{1}$$

$$= \frac{28}{8}$$

$$= 3\frac{4}{8}$$

$$= 3\frac{1}{2}$$

$$1\frac{1}{4} \div \frac{1}{2} = \frac{5}{4} \times \frac{2}{1}$$

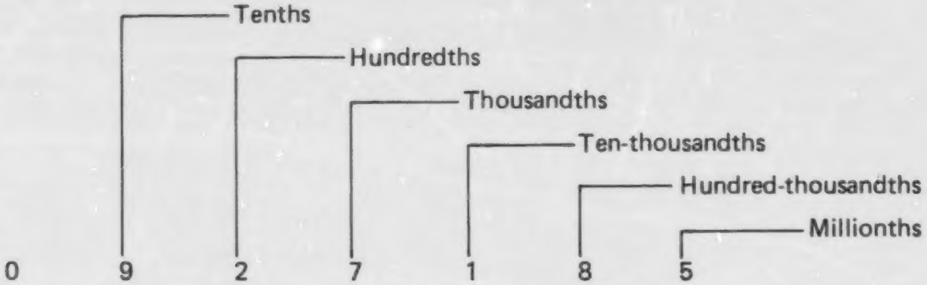
$$= \frac{10}{4}$$

$$= 2\frac{2}{4}$$

$$= 2\frac{1}{2}$$

INFORMATION SHEET

XV. Place value of decimals



EXAMPLES: In the number above, the place values are

Tenth = $\frac{9}{10}$

Hundredths = $\frac{2}{100}$

Thousandths = $\frac{7}{1000}$

Ten-thousandths = $\frac{1}{10{,}000}$

Hundred-thousandths = $\frac{8}{100{,}000}$

Millionths = $\frac{5}{1{,}000{,}000}$

The number is read as nine hundred twenty-seven thousand, one hundred eighty-five millionths (0.927185)

XVI. Converting fractions to decimals (Assignment Sheet #9)

(NOTE: Fractions with ten or a power of ten as the denominator may be easily written as decimals.)

A. Allow as many decimal places as there are zeros in the denominator

B. Place a decimal point in front of the numerator and leave off the denominator

(NOTE: Zeros may be needed as place holders.)

EXAMPLES: $\frac{1}{10} = 0.1$ $\frac{3}{100} = 0.03$ $\frac{79}{100} = 0.79$

C. Write mixed numbers with the whole number to the left of the decimal point

EXAMPLES: $1\frac{1}{10} = 1.1$

$3\frac{7}{100} = 3.07$

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XVII. Adding decimals (Assignment Sheet #10)

A. Write the given numbers in a column with the decimal points directly under each other

(NOTE: Whole numbers, such as 7 or 75 or 753, have understood decimal points, such as 7.00 or 75.00 or 753.00.)

B. Add each column of numbers the same as for regular whole numbers

C. Locate the decimal point in the answer by placing it directly under the decimal points above

EXAMPLE: 0.857 + 2.1 + 370.057 + 753 = 1126.014

$$\begin{array}{r} 0.857 \\ 2.1 \\ 370.057 \\ +\ 753. \\ \hline 1126.014 \end{array} \qquad \text{OR} \qquad \begin{array}{r} 0.857 \\ 2.100 \\ 370.057 \\ +\ 753.000 \\ \hline 1126.014 \end{array}$$

(NOTE: Zeros may be added so that each number has the same number of decimal places.)

XVIII. Subtracting decimals (Assignment Sheet #10)

A. Solving problems

1. Write the given numbers so that the decimal points are under each other
2. Subtract each column of numbers the same as for regular whole numbers
3. Place decimal point in the answer (difference) under the decimal points above

EXAMPLE:

$$\begin{array}{r} 8.120 \\ -\ 1.397 \\ \hline 6.723 \end{array}$$

B. Checking problems

1. Add the answer (difference) and the number just above it

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2. Notice that the sum must be the same as the top number in the problem for the answer to be correct

EXAMPLE:

$$\begin{array}{r} 8.120 \\ -\,1.397 \\ \hline 6.723 \end{array} \qquad \text{Check} \quad \begin{array}{r} 1.397 \\ +\,6.723 \\ \hline 8.120 \end{array}$$

(NOTE: If problem contains a whole number, you may add as many zeros to the right of the decimal point as you need.)

XIX. Multiplying decimals (Assignment Sheet #10)

A. Multiply the same as whole numbers

(NOTE: In setting up multiplication problems, you do not need to place the decimal points in columns.)

B. Total the number of decimal places to the right of the decimal points in the factors being multiplied

C. Locate the decimal point in the product by starting at the extreme right digit in the answer and counting off as many places to the left as the total found in step B indicates

EXAMPLES: Multiply 27.125 by 7.75

$$\begin{array}{rl} 27.125 & -\text{ 3 places} \\ \times 7.75 & \text{-- 2 places} \\ \hline 135625 & \\ 189875 & \\ 189875 & \\ \hline 210.21875 & -\text{ 5 places} \end{array}$$

Multipy 2.5 x .25

$$\begin{array}{rl} 2.5 & \text{-- 1 place} \\ \times .25 & \text{-- 2 places} \\ \hline 125 & \\ 50 & \\ \hline 0.625 & \text{-- 3 places} \end{array}$$

XX. Dividing a decimal by a decimal (Assignment Sheet #10)

A. Count the number of digits to the right of the decimal point in the divisor

B. Place a caret (∧) at the end of the number, making divisor a whole number

C. Count as many digits to the right of the decimal point in the dividend as you counted in the divisor

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D. Place a caret after the last digit you count

(NOTE: You may need to place some zeros in the dividend to the right of the last digit.)

E. Place the decimal point in the quotient directly above the caret in the dividend

F. Divide as with whole numbers

G. Check by multiplying the quotient and the divisor

EXAMPLES:

$$\begin{array}{r} 00.5 \\ 0.5_{\wedge}\overline{)\,0.2_{\wedge}5} \end{array} \qquad \text{Check} \quad \begin{array}{r} 0.5 \\ \times\,0.5 \\ \hline 0.25 \end{array}$$

$$\begin{array}{r} 5. \\ 0.05_{\wedge}\overline{)\,0.25_{\wedge}} \end{array} \qquad \text{Check} \quad \begin{array}{r} 0.05 \\ \times\,05 \\ \hline 0.25 \end{array}$$

$$0.005\overline{)\,0.25} \text{ becomes } \begin{array}{r} 50. \\ 0.005_{\wedge}\overline{)\,0.250_{\wedge}} \end{array} \qquad \text{Check} \quad \begin{array}{r} 0.005 \\ \times\,50 \\ \hline 0.250 \end{array}$$

XXI. Dividing a whole number by a decimal (Assignment Sheet #10)

A. Place a decimal point in the dividend at the right side of the number

B. Count the number of digits to the right of the decimal point in the divisor

C. Place a caret (∧) at the end of the number

D. Write as many zeros after the decimal point in the dividend as you counted places in the divisor

E. Place a caret after the last zero

F. Place a decimal point in the quotient directly above the caret in the dividend

G. Divide as with whole numbers

(NOTE: Zeros may need to be added beyond the caret if the division does not come out even.)

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H. Check by multiplying the divisor and quotient

EXAMPLE: $0.03\overline{)\,9}$ becomes $\begin{array}{r} 300. \\ 0.03_{\wedge}\overline{)\,9.00_{\wedge}} \end{array}$ Check $\begin{array}{r} 300 \\ \times\, 0.03 \\ \hline 9.00 \end{array}$

XXII. Converting fractions to decimals and percentages (Assignment Sheet #9)

A. Fractions as decimals--Divide the numerator by the denominator

EXAMPLE: $\frac{5}{8}$

$$\begin{array}{r} 0.625 \\ 8\overline{)\,5.000} \\ 4\,8 \\ \hline 20 \\ 16 \\ \hline 40 \\ 40 \\ \hline 0 \end{array}$$

B. Fractions as percentages

1. Convert the fraction to decimal form
2. Move the decimal point two places to the right
3. Place the percent symbol (%) after the number

EXAMPLE: $\frac{7}{33}$

$$\begin{array}{r} 0.2121 \\ 33\overline{)\,7.0000} \\ 6\,6 \\ \hline 40 \\ 33 \\ \hline 70 \\ 66 \\ \hline 40 \\ 33 \\ \hline 7 \end{array} = 0.2121 = 21.21\%$$

(NOTE: Percent means that a number is a fraction of 100.)

XXIII. Converting percentages to fractions and decimals (Assignment Sheet #11)

A. Percentages as fractions

1. Drop the percent symbol (%)
2. Place the number over 100

(NOTE: Reduce to lowest terms.)

EXAMPLES: $38\% = \frac{38}{100} = \frac{19}{50}$

$33\frac{1}{3}\% = \frac{33\frac{1}{3}}{100} = \frac{\frac{100}{3}}{100} = \frac{1}{3}$

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B. Percentages as decimals

1. Drop the percent symbol (%)
2. Move the decimal point two places to the left

EXAMPLES: 74% = 0.74

$33\frac{1}{3}\% = 0.33$

XXIV. Solving percentage problems (Assignment Sheet #11)

A. Write the unknown as "X"

(NOTE: The unknown may be the percent, the part, or the whole.)

B. Write all percentages as a fraction of 100

C. Make a fraction by placing the part over the whole amount

D. Write the two fractions with an equal sign between them

E. Cross multiply and solve the resulting equation

EXAMPLES: 16 (part) is what percent of 80 (whole)?

$$\frac{16}{80} = \frac{X}{100}$$

$80X = 1600$ (Divide 80 into 1600)

$X = 20\%$

5% of 97.3 is what number?

$$\frac{5}{100} = \frac{X}{97.3}$$

$100X = 486.5$ (Divide 100 into 486.5, or move the decimal point two places to the left)

$X = 4.865$

26 is 40% of what number?

$$\frac{26}{X} = \frac{40}{100}$$

$40X = 2600$ (Divide 40 into 2600)

$X = 65$

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XXV. Common fractional and decimal equivalents

A. 1/16 = 0.0625

B. 1/8 = 0.125

C. 1/4 = 0.25

D. 3/8 = 0.375

E. 1/2 = 0.5

F. 5/8 = 0.625

G. 3/4 = 0.75

H. 7/8 = 0.875

XXVI. Standard measures and equivalents (Assignment Sheet #14)

A. Linear measure

12 inches (in) = 1 foot (ft)

3 ft = 1 yard (yd)

1,760 yd = 1 mile (mi)

5,280 ft = 1 mile (mi)

B. Surface measure

144 sq in = 1 sq ft

9 sq ft = 1 sq yd

4,840 sq yd = 1 acre

640 acres = 1 sq mi

C. Cubic measure

1,728 cu in = 1 cu ft

27 cu ft = 1 cu yd

D. Liquid measure

16 ounces (oz) = 1 pint (pt)

2 pt = 1 quart (qt)

4 qt = 1 gallon (gal)

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1 gal water = 8 1/2 pounds (lb)

7 1/2 gal = 1 cu ft

55 gal = 1 drum (barrel)

30 gal = 1/2 drum (1/2 barrel)

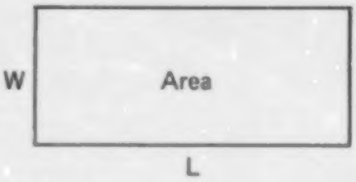
(NOTE: The 55-gallon drum is the standard measure for most materials used by the department of transportation. However, drum size may vary with the contents.)

XXVII. Basic formulas for surface area, area of a triangle, and volume (Assignment Sheet #14)

A. Surface area--Area = Length x Width

(NOTE: Surface area is expressed in *square* inches, feet, yards, miles, or acres.)

EXAMPLE: A = L x W



A parking lot is 200 feet long and 150 feet wide. What is the area?

A = L x W

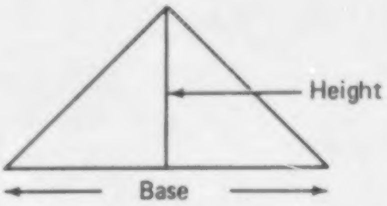
= 200 x 150

= 30,000 sq ft

B. Area of a triangle--A = 1/2 the Base x Height

(NOTE: Area is expressed in *square* inches, feet, or yards.)

EXAMPLE: A = 1/2 B x H



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What is the surface area of a triangular pothole 3 feet long and 6 feet across?

A = 1/2 B x H

= 1/2 (3 x 6)

= 1/2 x 18

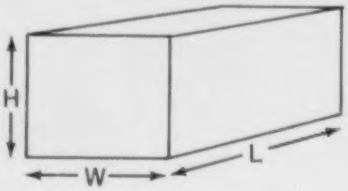
= 9 sq ft

= 1 sq yd

C. Volume--Volume = Length x Width x Height

(NOTE: Volume is expressed in *cubic* inches, feet, or yards.)

EXAMPLE: V = L x W x H



A dump bed is 10 feet long, 7 feet wide and 2 feet high. How many cubic yards of material will it hold?

V = L x W x H

= 10 x 7 x 2

= 140 cu ft

= 140 27 (Convert cubic feet to cubic yards.)

= 5.19 cu yd

XXVIII. Solving mix ratio problems (Assignment Sheet #12)

(NOTE: Ratios compare only *like* quantities such as gallons to gallons, feet to feet. You cannot have a ratio of inches to feet.)

A. Figure out the terms of the ratio

(NOTE: The order of numbers in a ratio corresponds to the order of materials or objects as stated.)

EXAMPLE: Mix sand and salt to a ratio of 2:1, OR
mix salt and sand to a ratio of 1:2

Sand--2 parts (may be cubic yards, truckloads, 5-gal buckets)
Salt--1 part (must be same kind of measurement as sand)

INFORMATION SHEET

B. Reduce ratio to lowest terms for easier handling

EXAMPLES: 3:180 = 1:60 4:12 = 1:3 75:25 = 3:1

C. Divide the given amount by the number of parts to find one part

EXAMPLE: You have 360 cu yd of sand, how much aggregate will you need to mix a 3:2 ratio of sand and aggregate?

360 ÷ 3 = 120 (1 part)

D. Multiply that amount by the number of parts of the unknown quantity or quantities

EXAMPLES:

1. You have 360 cu yd of sand, how much aggregate will you need to mix a 3:2 ratio of sand and aggregate?

   360÷3 = 120 x 2 = 240 cu yd of aggregate

2. Mix sand and salt to a ratio of 3:1. You have 420 cu yd of sand. How much salt will you need?

   420÷3 = 140 cu yd of salt (1 part)

3. The ratio of cement, sand, and aggregate to mix concrete is 2:2:3 If you have 20 cubic feet of cement, how much sand and aggregate will you need?

   Cement 1 part = 20 ÷ 2 = 10 cu ft

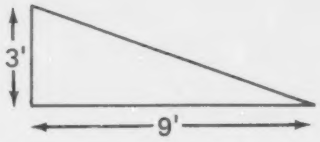
   Sand 2 parts = 2 x 10 = 20 cu ft

   Aggregate 3 parts = 3 x 10 = 30 cu ft

XXIX. Solving slope ratio problems (Assignment Sheet #13)

(NOTE: Slope ratio is expressed in two numbers. The first number always refers to the horizontal distance, and the second number always refers to the vertical distance.)

EXAMPLE:



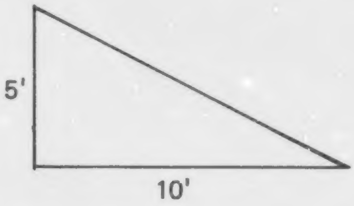
The ratio is 9:3; reduced to its lowest terms, the slope ratio is 3:1.

INFORMATION SHEET

A. Find the slope ratio, given the vertical and horizontal distance

1. State the ratio in feet as horizontal feet (:) vertical distance

   EXAMPLE:



10:5

2. Find the highest number which will divide evenly into both numbers; or divide the vertical distance into the horizontal distance

   EXAMPLES:

   $10:5 = 2:1$ OR $\frac{10}{5} = 2:1$

   $15:7 = \frac{15}{7} = 2.14:1$

3. Reduce answer to lowest terms

B. Find the vertical distance, given the slope ratio and the horizontal distance

1. Divide the horizontal distance by the first term in the ratio to find one part

2. Multiply the answer by the second term in the ratio

   EXAMPLES: 1. Slope ratio is 3:1; horizontal distance is 33 feet.

   $\frac{33}{3} = 11$ feet (1 part) $11 \times 1 = 11$ feet vertical distance

   2. Slope ratio is 4:3; horizontal distance is 36 feet.

   $\frac{36}{4} = 9$ feet (1 part) $9 \times 3 = 27$ feet vertical distance

C. Find the horizontal distance, given the slope ratio and the vertical distance

1. Divide the vertical distance by the second term in the ratio to find one part

   (NOTE: If the second term is 1, as in 3:1, leave this step out.)

INFORMATION SHEET

2. Multiply the answer (or the vertical distance if the ratio is ___:1) by the first term in ratio

EXAMPLES:

1. Slope ratio is 4:1; vertical distance is 2 feet.

   2 x 4 = 8 feet horizontal distance

2. Slope ratio is 8:3; vertical distance is 6 feet.

   $\frac{6}{3}$ = 2 feet (1 part)

   8 x 2 = 16 feet horizontal distance

Math Function Terms

6.213 ← Addend
4.070 ← Addend
7.655 ← Addend
+ 8.000 ← Addend
25.938 ← Sum or total

42.630 ← Minuend
− 18.275 ← Subtrahend
24.355 ← Difference

43.286 ← Multiplicand
× 6.04 ← Multiplier
173144 ← Partial product
00000 ← Partial product
259716 ← Partial product
261.44744 ← Product

31.72 ← Quotient
Divisor → 2.4⟌76.129 ← Dividend
^72 ^
41
24
172
168
49
48
1 ← Remainder

BASIC MATH
UNIT III

ASSIGNMENT SHEET #1--SOLVE ADDITION PROBLEMS

NAME ______________________________ SCORE ______________

Like most people, you probably use addition every day. Today, for example you may have added coins together to pay for a cup of coffee or a snack. Every time you add, you use some basic addition facts. The numbers that are added together are called *addends*. The answer obtained in the addition problem is called the *sum* or *total*.

A. Solve each of the following addition problems for the sum or total.

1. 7 + 1	2. 2 + 9	3. 2 + 5	4. 2 + 8	5. 4 + 4	6. 4 + 1	7. 3 + 1
8. 3 + 3	9. 1 + 1	10. 9 + 2	11. 8 + 8	12. 8 + 3	13. 1 + 6	14. 9 + 8

B. In adding numbers with more than one digit, note that the digits on the left of the ones column in no way affect the sum of the digits in the ones column. Also, each of the following problems will require carrying.

EXAMPLE:
1 ← Carried number
67
+ 25
92

7 + 5 = 12
Record the 2 and carry the 1
The carried 1 + 6 + 2 = 9
Record the 9

Solve each of the following addition problems for the sum or total.

1. 49 81 + 27	2. 37 74 + 66	3. 92 38 + 77	4. 87 26 + 44	5. 44 57 + 63
6. 28 41 + 82	7. 36 81 + 74	8. 67 38 + 43	9. 64 78 + 32	10. 72 38 + 25

ASSIGNMENT SHEET #1

C.

1. $\begin{array}{r} 576 \\ 953 \\ 462 \\ +\,615 \\ \hline \end{array}$
2. $\begin{array}{r} 333 \\ 478 \\ 962 \\ +\,510 \\ \hline \end{array}$
3. $\begin{array}{r} 747 \\ 324 \\ 600 \\ +\,598 \\ \hline \end{array}$
4. $\begin{array}{r} 909 \\ 636 \\ 877 \\ +\,965 \\ \hline \end{array}$
5. $\begin{array}{r} 396 \\ 728 \\ 220 \\ +\,494 \\ \hline \end{array}$
6. $\begin{array}{r} 923 \\ 934 \\ 966 \\ +\,123 \\ \hline \end{array}$
7. $\begin{array}{r} 327 \\ 240 \\ 136 \\ +\,238 \\ \hline \end{array}$
8. $\begin{array}{r} 270 \\ 368 \\ 609 \\ +\,224 \\ \hline \end{array}$

D. If one leg of a snowplow job is 9 miles, the second leg 3 miles, and the third leg 8 miles, what is the total distance?

________________________ miles

E. If you have to make a fill of 4 inches of sand, 6 inches of gravel, and 3 inches of soil, what is the total fill?

________________________ inches

F. How much will an operator lift if the tools weigh 50 lb, the hose 21 lb, the nozzle 47 lb, and the sign 52 lb?

________________________ pounds

G. How much fuel was used in one day for all the equipment when the grader used 20 gal, the dozer used 22 gal, the crane used 25 gal, the backhoe used 32 gal, and the lift used 16 gal?

________________________ gallons

H. How much wire rope is available if one spool contains 242 ft; the second, 318 ft; the third, 409 ft; and the fourth, 171 ft?

________________________ feet

I. If a crew works 320 hours one week, 416 hours the next week, 345 hours the third week, and 218 hours the fourth week, how many hours did the crew work in that month?

________________________ hours

J. While repairing surface failures, a crew laid 528 sq ft of aggregate on the first job, 640 sq ft on the second job, and 580 sq ft on the third job. How many square feet did the crew cover?

________________________ sq ft

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BASIC MATH
UNIT III

ASSIGNMENT SHEET #2--SOLVE SUBTRACTION PROBLEMS

NAME ________________________ SCORE ____________

Addition is the first fundamental operation in mathematics. Subtraction is the second. You can check the accuracy of the answer in a subtraction problem by adding the difference to the subtrahend. The sum of these two numbers must equal the minuend if the answer is correct.

EXAMPLE:

$$\begin{array}{r} 57 \\ -35 \\ \hline 22 \end{array}$$

Subtract 5 from 7 and record the 2
Subtract 3 from 5 and record the 2
Answer or difference is 22
Add 22 to 35 = 57
Answer is correct

When the digits in the bottom figure (subtrahend) are greater than the corresponding digits in the top figure (minuend), you must borrow from the next column to the left in the minuend.

EXAMPLE:

$$\begin{array}{r} 64 \\ -25 \\ \hline 39 \end{array}$$

The number 5 is greater than 4, so borrow 1 ten from the 6 in the tens column, leaving 5 tens.

Take the ten borrowed and add it to the 4 in the ones column, making 14.

$$\begin{array}{r} 5\,1 \\ \cancel{6}4 \\ -25 \\ \hline 39 \end{array}$$

Subtract 5 from 14, leaving 9 in the ones column.

Subtract 2 from 5, leaving 3 in the tens column.

Solve each of the following subtraction problems to find the difference or remainder.

A.

1. $\begin{array}{r} 6 \\ -1 \\ \hline \end{array}$
2. $\begin{array}{r} 2 \\ -1 \\ \hline \end{array}$
3. $\begin{array}{r} 5 \\ -2 \\ \hline \end{array}$
4. $\begin{array}{r} 6 \\ -3 \\ \hline \end{array}$
5. $\begin{array}{r} 3 \\ -1 \\ \hline \end{array}$
6. $\begin{array}{r} 7 \\ -1 \\ \hline \end{array}$
7. $\begin{array}{r} 4 \\ -3 \\ \hline \end{array}$

B.

1. $\begin{array}{r} 75 \\ -56 \\ \hline \end{array}$
2. $\begin{array}{r} 84 \\ -57 \\ \hline \end{array}$
3. $\begin{array}{r} 4635 \\ -3187 \\ \hline \end{array}$
4. $\begin{array}{r} 4178 \\ -1539 \\ \hline \end{array}$

ASSIGNMENT SHEET #2

C.	1. 218 - 119	2. 983 - 656	3. 771 - 289	4. 53 - 39
D.	1. 74 - 26	2. 62 - 29	3. 77 - 39	4. 123 - 67
E.	1. 111 - 79	2. 204 - 78	3. 356 - 178	4. 378 - 179
F.	1. 4890 - 362	2. 365 - 209	3. 6720 - 4890	4. 7650 - 2312

G. If it takes 11 bolts for a scraper frame and you already have 9 bolts, how many bolts will you need?

____________________ bolts

H. How much of a fill would have to be made on a drainage ditch that is 47 in low, and it is decided to fill it to 26 in low?

____________________ in

I. If the boom on a side boom is 18 ft and you need 25 ft to do a particular job, how much boom would have to be added?

____________________ ft

J. If guardrails were placed along 2,488 linear ft of roadway the first day, and the operator needed to place them along 8,572 linear ft that week, how much more distance would have to be covered in the remaining four days?

____________________ linear ft

BASIC MATH
UNIT III

ASSIGNMENT SHEET #3--SOLVE MULTIPLICATION PROBLEMS

NAME ______________________________ SCORE ________________

Multiplication is the third basic operation in mathematics. It is a shortcut method of adding. For example, if you correctly add twelve 12's, the result will be 144, the same as 12 multiplied by 12.

EXAMPLE: 7 x 8 = 56

$$\begin{array}{r} 8 \\ \times\ 7 \\ \hline 56 \end{array}$$

Some multiplication problems involve carrying. You may write down the carried numerals, or simply remember them. Use the method that works best for you.

EXAMPLE:

1 ← Carried number
53
4 x 3 = 12
Record the 2 and carry the 1
x 4
2

1 ← Carried number
53
4 x 5 = 20
20 + the carried 1 = 21
x 4
Record the 21
212
Product is 212

Keep partial products properly aligned when multiplying numbers with two or more digits.

EXAMPLE:

11 ← Carried numbers
756
x312
1512 ← First partial product
756 ← Second partial product
2268 ← Third partial product
235,872 ← Product

ASSIGNMENT SHEET #3

Solve each of the following multiplication problems to find the products.

A. 1. $\begin{array}{r}6\\ \underline{\times 2}\end{array}$ 2. $\begin{array}{r}0\\ \underline{\times 4}\end{array}$ 3 $\begin{array}{r}3\\ \underline{\times 6}\end{array}$ 4. $\begin{array}{r}7\\ \underline{\times 2}\end{array}$ 5. $\begin{array}{r}2\\ \underline{\times 4}\end{array}$ 6. $\begin{array}{r}3\\ \underline{\times 8}\end{array}$ 7. $\begin{array}{r}4\\ \underline{\times 5}\end{array}$

B. 1. $\begin{array}{r}42\\ \underline{\times 2}\end{array}$ 2. $\begin{array}{r}53\\ \underline{\times 5}\end{array}$ 3. $\begin{array}{r}156\\ \underline{\times 4}\end{array}$ 4. $\begin{array}{r}703\\ \underline{\times 5}\end{array}$ 5. $\begin{array}{r}659\\ \underline{\times 3}\end{array}$

C. 1. $\begin{array}{r}63\\ \underline{\times 38}\end{array}$ 2. $\begin{array}{r}85\\ \underline{\times 76}\end{array}$ 3. $\begin{array}{r}32\\ \underline{\times 59}\end{array}$ 4. $\begin{array}{r}42\\ \underline{\times 96}\end{array}$ 5. $\begin{array}{r}73\\ \underline{\times 64}\end{array}$ 6. $\begin{array}{r}54\\ \underline{\times 83}\end{array}$

D. 1. $\begin{array}{r}95\\ \underline{\times 74}\end{array}$ 2. $\begin{array}{r}95\\ \underline{\times 54}\end{array}$ 3. $\begin{array}{r}67\\ \underline{\times 43}\end{array}$ 4. $\begin{array}{r}64\\ \underline{\times 77}\end{array}$ 5. $\begin{array}{r}82\\ \underline{\times 77}\end{array}$ 6. $\begin{array}{r}99\\ \underline{\times 67}\end{array}$

E. 1. $\begin{array}{r}556\\ \underline{\times 554}\end{array}$ 2. $\begin{array}{r}949\\ \underline{\times 979}\end{array}$ 3. $\begin{array}{r}262\\ \underline{\times 192}\end{array}$ 4. $\begin{array}{r}567\\ \underline{\times 485}\end{array}$ 5. $\begin{array}{r}879\\ \underline{\times 729}\end{array}$ 6. $\begin{array}{r}889\\ \underline{\times 445}\end{array}$

ASSIGNMENT SHEET #3

F. If a load of fill weighs 18,796 lb, how much would 78 loads weigh?

_____________________________ pounds

G. If a dragline could stockpile 676 cubic yd of dirt in two days, how much could be stockpiled in 14 days?

_____________________________ cubic yards

H. How many square feet in a sidewalk 9' long and 3' wide?

_____________________________ square feet

I. What is the total square footage of a concrete pad 9' long by 8' wide?

_____________________________ square feet

J. If one dump truck carries 18 tons of material, how many tons will be hauled in a 5-day week if the truck makes 7 trips a day?

_____________________________ tons

BASIC MATH
UNIT III

ASSIGNMENT SHEET #4--SOLVE DIVISION PROBLEMS

NAME ____________________ SCORE ____________

Division is the fourth and last basic operation in mathematics. Multiplication puts together; division takes apart. Division is really the reverse of multiplication.

EXAMPLE: $972 \div 3 = 324$

$$\begin{array}{r} 324 \\ 3\overline{)972} \\ \underline{9} \\ 7 \\ \underline{6} \\ 12 \\ \underline{12} \end{array}$$

A. Solve each of the division problems to find the quotient.

(NOTE: You can check your own answers to division problems by multiplying.)

1. $3\overline{)6}$
2. $7\overline{)21}$
3. $5\overline{)225}$
4. $6\overline{)3600}$
5. $5\overline{)5}$
6. $4\overline{)16}$
7. $8\overline{)96}$
8. $9\overline{)81}$

ASSIGNMENT SHEET #4

B. *Long division* is the name used for division by numbers that cannot readily be used as simple divisors. The individual products and remainders, because of their length, are written.

EXAMPLE: $5678 \div 51 = 111$ R (remainder) 17

$$
\begin{array}{rrl}
 & 111 & \leftarrow \text{quotient} \\
51 & \overline{)\,5678} & \\
 & \underline{51} & \\
 & 57 & \\
 & \underline{51} & \\
 & 68 & \\
 & \underline{51} & \\
 & 17 & \leftarrow \text{remainder}
\end{array}
$$

Solve each of the following division problems to find the quotient.

1. $12\overline{)24}$

2. $30\overline{)90}$

3. $66\overline{)198}$

4. $15\overline{)60}$

5. $23\overline{)276}$

6. $19\overline{)152}$

ASSIGNMENT SHEET #4

7. $26\,\overline{)\,8507}$

8. $62\,\overline{)\,7739}$

9. $28\,\overline{)\,5212}$

C. If a forklift travels 4,572 miles a year, how far would it travel in one month?

______________________________ miles

D. If the distance across a ravine is 13,608 ft, and the equipment can move only 90 ft per day, how long will it take for the equipment to cross?

______________________________ days

BASIC MATH
UNIT III

ASSIGNMENT SHEET #5--CONVERT FRACTIONS

NAME ______________________________ SCORE ______________

A fraction such as 3/4 is called a *proper fraction.* This is because the numerator (top number) is smaller than the denominator (bottom number). Some examples of proper fractions are 2/3, 1/5, and 7/8.

When the numerator of a fraction is the same, or larger, than the denominator, the fraction is called an *improper fraction.* Some examples of improper fractions are 4/4, 5/3, 9/4, and 10/8.

Numbers such as 2 1/2, 5 3/4, and 6 2/5 are called *mixed numbers.* They are made up of a whole number and a fraction.

A. Convert each of the following mixed numbers to improper fractions. (Do not reduce answers to lowest terms at this time.)

1. $3\frac{1}{4} =$ ______
2. $4\frac{1}{2} =$ ______
3. $7\frac{1}{3} =$ ______
4. $8\frac{1}{2} =$ ______
5. $6\frac{2}{3} =$ ______
6. $5\frac{1}{5} =$ ______
7. $4\frac{2}{3} =$ ______
8. $8\frac{1}{7} =$ ______
9. $9\frac{1}{5} =$ ______
10. $16\frac{2}{3} =$ ______
11. $2\frac{1}{2} =$ ______
12. $3\frac{2}{4} =$ ______
13. $7\frac{3}{4} =$ ______
14. $9\frac{2}{3} =$ ______
15. $5\frac{2}{3} =$ ______
16. $6\frac{1}{8} =$ ______
17. $3\frac{3}{4} =$ ______
18. $6\frac{4}{5} =$ ______
19. $4\frac{1}{3} =$ ______
20. $1\frac{4}{5} =$ ______

ASSIGNMENT SHEET #5

B. Convert each of the following improper fractions to mixed numbers. (Do not reduce answers to lowest terms at this time.)

1. $\frac{16}{5} =$ ______
2. $\frac{12}{5} =$ ______
3. $\frac{17}{3} =$ ______
4. $\frac{8}{3} =$ ______
5. $\frac{9}{2} =$ ______
6. $\frac{5}{3} =$ ______
7. $\frac{7}{2} =$ ______
8. $\frac{9}{4} =$ ______
9. $\frac{17}{16} =$ ______
10. $\frac{11}{5} =$ ______
11. $\frac{19}{13} =$ ______
12. $\frac{8}{7} =$ ______
13. $\frac{75}{32} =$ ______
14. $\frac{24}{17} =$ ______
15. $\frac{13}{9} =$ ______
16. $\frac{7}{4} =$ ______
17. $\frac{9}{6} =$ ______
18. $\frac{4}{3} =$ ______
19. $\frac{15}{4} =$ ______
20. $\frac{16}{7} =$ ______

BASIC MATH
UNIT III

ASSIGNMENT SHEET #6--REDUCE FRACTIONS TO LOWEST TERMS

NAME ______________________________ SCORE ______________

Fractions are "reduced" to their lowest terms so that they are more readily understood or recognized. For example 1/2 is more easily recognized than 16/32.

To reduce a fraction to lowest terms, divide the numerator and the denominator by all divisors that are common to both.

EXAMPLES:

$$\frac{18}{24} \div \frac{2}{2} = \frac{9}{12}$$

$$\frac{9}{12} \div \frac{3}{3} = \frac{3}{4}$$

Reduce the following fractions to the lowest terms.

A. $\frac{3}{9} =$ ______

B. $\frac{8}{24} =$ ______

C. $\frac{10}{15} =$ ______

D. $\frac{15}{25} =$ ______

E. $\frac{12}{48} =$ ______

F. $\frac{9}{24} =$ ______

G. $\frac{5}{7} =$ ______

H. $\frac{2}{4} =$ ______

I. $\frac{9}{12} =$ ______

J. $\frac{50}{100} =$ ______

K. $\frac{5}{5} =$ ______

L. $\frac{8}{12} =$ ______

M. $\frac{7}{21} =$ ______

N. $\frac{4}{8} =$ ______

O. $\frac{10}{12} =$ ______

P. $\frac{26}{52} =$ ______

Q. $\frac{6}{9} =$ ______

R. $\frac{13}{39} =$ ______

S. $\frac{9}{9} =$ ______

T. $\frac{12}{16} =$ ______

BASIC MATH
UNIT III

ASSIGNMENT SHEET #7--FIND LOWEST COMMON DENOMINATORS

NAME ______________________________ SCORE ______________

In the addition and subtraction of fractions, if the denominators are different, the fractions must be changed to equivalent fractions with a common denominator.

To change a fraction to its equivalent with a higher denominator, multiply the denominator of the given fraction by the number that will give the desired denominator; then multiply the numerator of the fraction by the same multiplier.

EXAMPLE: $\frac{1}{2} = \frac{\quad}{8}$ $\frac{1}{2} \times \frac{4}{4} = \frac{4}{8}$ $\frac{1}{2} = \frac{4}{8}$

To change a fraction to its equivalent with a lower denominator, proceed in like manner, but divide both the denominator and the numerator by the same number.

EXAMPLE: $\frac{12}{16} = \frac{\quad}{4}$ $\frac{12}{16} \div \frac{4}{4} = \frac{3}{4}$ $\frac{12}{16} = \frac{3}{4}$

PART I

Convert each of the following fractions to equivalent fractions with a common denominator.

A. 1. $\frac{1}{2} = \frac{\quad}{12}$ 2. $\frac{2}{3} = \frac{\quad}{12}$ 3. $\frac{3}{4} = \frac{\quad}{12}$ 4. $\frac{5}{6} = \frac{\quad}{12}$

B. 1. $\frac{1}{4} = \frac{\quad}{32}$ 2. $\frac{5}{8} = \frac{\quad}{32}$ 3. $\frac{7}{8} = \frac{\quad}{32}$ 4. $\frac{9}{16} = \frac{\quad}{32}$

C. 1. $\frac{12}{16} = \frac{\quad}{4}$ 2. $\frac{18}{24} = \frac{\quad}{4}$ 3. $\frac{24}{32} = \frac{\quad}{4}$ 4. $\frac{42}{56} = \frac{\quad}{4}$

D. 1. $\frac{15}{48} = \frac{\quad}{16}$ 2. $\frac{25}{80} = \frac{\quad}{16}$ 3. $\frac{28}{64} = \frac{\quad}{16}$ 4. $\frac{18}{32} = \frac{\quad}{16}$

ASSIGNMENT SHEET #7

PART II

The lowest common denominator (LCD) of a group of fractions is the smallest number into which all the denominators can be divided.

The LCD can be determined at a glance, or by simple figuring, such as multiplying the denominators together.

EXAMPLES:

3/8 and 3/4	It is easy to see that 8 is the LCD
5/6 and 3/4	It is easy to see that 12 is the LCD
7/8 and 4/5	Multiply 8 x 5 = 40 LCD
2/3, 1/7, and 2/5	Multiply 3 x 7 x 5 = 105 LCD

Find the lowest common denominator and convert each fraction to its LCD equivalent.

A. 1. $\frac{2}{3}, \frac{7}{9}$ LCD = ________

2. $\frac{2}{3} =$ ______

3. $\frac{7}{9} =$ ______

B. 1. $\frac{7}{8}, \frac{5}{6}$ LCD = ________

2. $\frac{7}{8} =$ ______

3. $\frac{5}{6} =$ ______

C. 1. $\frac{1}{3}, \frac{11}{12}, \frac{3}{8}$ LCD = ________

2. $\frac{1}{3} =$ ______

3. $\frac{11}{12} =$ ______

4. $\frac{3}{8} =$ ______

ASSIGNMENT SHEET #7

D. 1. $\frac{1}{7}, \frac{5}{8}$ LCD = ____________

2. $\frac{1}{7}$ = ________

3. $\frac{5}{8}$ = ________

E. 1. $\frac{1}{16}, \frac{3}{8}, \frac{3}{4}$ LCD = ____________

2. $\frac{1}{16}$ = ________

3. $\frac{3}{8}$ = ________

4. $\frac{3}{4}$ = ________

F. 1. $\frac{5}{18}, \frac{3}{4}, \frac{1}{9}$ LCD = ____________

2. $\frac{5}{18}$ = ________

3. $\frac{3}{4}$ = ________

4. $\frac{1}{9}$ = ________

BASIC MATH
UNIT III

ASSIGNMENT SHEET #8--ADD, SUBTRACT, MULTIPLY, AND DIVIDE FRACTIONS

NAME ______________________ SCORE __________

Whenever something is divided into parts, you will need to solve the problems using fractions.

PART I--Add fractions

To add common fractions, change to equivalent fractions with lowest common denominators. Add the new numerators and place this sum over the lowest common denominator. If the result is an improper fraction, change it to a mixed number and reduce to lowest terms.

EXAMPLE:

$$\frac{2}{3}+\frac{3}{4}=\frac{8}{12}+\frac{9}{12}$$

$$=\frac{17}{12}$$

$$=1\frac{5}{12}$$

Find common denominators and add the following fractions. Reduce to lowest terms.

A. $\frac{1}{4}+\frac{2}{3}=$ _____

B. $\frac{3}{4}+\frac{5}{6}=$ _____

C. $\frac{4}{5}+\frac{3}{4}=$ _____

D. $\frac{5}{8}+\frac{5}{6}=$ _____

E. $\frac{5}{9}+\frac{4}{7}=$ _____

F. $\frac{2}{5}+\frac{4}{9}=$ _____

G. $\frac{7}{12}+\frac{5}{8}=$ _____

H. $\frac{3}{5}+\frac{2}{3}=$ _____

ASSIGNMENT SHEET #8

I. $\frac{1}{3} + \frac{11}{12} + \frac{3}{8} =$ ______

J. $\frac{1}{16} + \frac{3}{8} + \frac{3}{4} =$ ______

K. $\frac{3}{20} + \frac{3}{4} + \frac{7}{10} + \frac{4}{5} =$ ______

L. $\frac{5}{18} + \frac{3}{4} + \frac{1}{9} =$ ______

M. $\frac{3}{4} + \frac{7}{8} =$ ______

N. $\frac{2}{5} + \frac{5}{8} =$ ______

ASSIGNMENT SHEET #8

PART II--Subtract fractions

To subtract fractions, change to equivalent fractions with common denominators. Find the difference between the numerators of the equivalent fractions. Place the difference over the common denominator and, if necessary, reduce the answer to lowest terms.

EXAMPLE: $\frac{2}{3} - \frac{1}{4} = \frac{8}{12} - \frac{3}{12}$

$= \frac{5}{12}$

Subtract each of the following common fractions. Reduce to lowest terms.

A. $\frac{3}{4} - \frac{2}{3} =$ ______

B. $\frac{2}{3} - \frac{1}{2} =$ ______

C. $\frac{7}{8} - \frac{2}{3} =$ ______

D. $\frac{4}{5} - \frac{3}{8} =$ ______

E. $\frac{4}{5} - \frac{5}{12} =$ ______

F. $\frac{9}{10} - \frac{2}{3} =$ ______

G. $\frac{5}{6} - \frac{5}{8} =$ ______

H. $\frac{6}{7} - \frac{5}{9} =$ ______

I. $\frac{5}{9} - \frac{3}{8} =$ ______

J. $\frac{1}{3} - \frac{5}{16} =$ ______

ASSIGNMENT SHEET #8

PART III--Multiply fractions

Multiply the numerators and denominators separately. Write the product of the numerator over the product of the denominator and reduce to lowest terms.

EXAMPLE: $\frac{2}{3} \times \frac{3}{4} = \frac{2 \times 3}{3 \times 4}$

$= \frac{6}{12}$

$= \frac{1}{2}$

Multiply the following fractions. Convert improper fractions where needed and reduce answers to the lowest terms.

A. $\frac{1}{2} \times \frac{3}{4} =$ _____

B. $\frac{3}{8} \times \frac{5}{16} =$ _____

C. $1\frac{1}{2} \times 2\frac{1}{4} =$ _____

D. $\frac{1}{2} \times 6\frac{1}{2} =$ _____

E. $\frac{7}{8} \times \frac{2}{3} =$ _____

F. $1\frac{1}{3} \times 2\frac{1}{4} \times \frac{1}{2} =$ _____

G. $\frac{1}{4} \times \frac{1}{3} \times \frac{1}{2} =$ _____

H. $2\frac{3}{4} \times 6\frac{1}{8} =$ _____

ASSIGNMENT SHEET #8

PART IV--Divide fractions

Invert the divisor, then multiply.

EXAMPLE: $\frac{7}{8} \div \frac{1}{4} = \frac{7}{8} \times \frac{4}{1}$

$= \frac{28}{8}$

$= 3\frac{4}{8}$

$= 3\frac{1}{2}$

Solve the following division problems. Reduce answers to lowest terms.

A. $\frac{7}{8} \div \frac{3}{4} =$ ______

B. $\frac{3}{4} \div \frac{2}{1} =$ ______

C. $\frac{5}{6} \div \frac{4}{5} =$ ______

D. $3\frac{1}{2} \div \frac{3}{4} =$ ______

E. $\frac{9}{10} \div \frac{1}{3} =$ ______

F. $7\frac{1}{3} \div \frac{4}{5} =$ ______

G. $\frac{3}{8} \div \frac{1}{2} =$ ______

H. $8 \div \frac{3}{5} =$ ______

I. $12\frac{3}{8} \div 1\frac{1}{2} =$ ______

J. $2\frac{2}{3} \div \frac{1}{16} =$ ______

BASIC MATH
UNIT III

ASSIGNMENT SHEET #9--CONVERT FRACTIONS TO DECIMALS

NAME ______________________________ SCORE ______________

Common fractions can also be expressed as decimal fractions, called decimals.

EXAMPLES:

$1\frac{5}{10} = 1.5$ → tenths

$1\frac{25}{100} = 1.25$ → hundredths

$1\frac{125}{1000} = 1.125$ → thousandths

A. Match the decimal notations on the right to their correct equivalent fractions. Write the correct letters of the matching answers in the blanks.

_____ 1. $5\frac{6}{10}$

_____ 2. $1\frac{2}{100}$

_____ 3. $\frac{87}{1000}$

_____ 4. $7\frac{83}{1000}$

_____ 5. $5\frac{6}{100}$

_____ 6. $5\frac{6}{1000}$

_____ 7. $78\frac{3}{10}$

_____ 8. $87\frac{7}{10}$

_____ 9. 102

_____ 10. $\frac{783}{1000}$

a. 7.083

b. 5.006

c. 78.3

d. 0.087

e. 0.783

f. 87.7

g. 5.6

h. 102.0

i. 5.06

j. 1.02

ASSIGNMENT SHEET #9

B. Write the following numbers in decimal notation.

1. $63\frac{9}{10}$ = ____________________

2. $5\frac{93}{100}$ = ____________________

3. $5\frac{93}{1000}$ = ____________________

4. $5\frac{93}{10000}$ = ____________________

5. $3\frac{825}{1000}$ = ____________________

6. $38\frac{95}{100}$ = ____________________

7. $38\frac{95}{1000}$ = ____________________

8. $42\frac{3}{10}$ = ____________________

9. $402\frac{3}{10}$ = ____________________

10. $897\frac{97}{100000}$ = ____________________

BASIC MATH
UNIT III

ASSIGNMENT SHEET #10--ADD, SUBTRACT, MULTIPLY, AND DIVIDE DECIMALS

NAME ____________________________________ SCORE ____________

Solving problems with decimals is the same as solving problems with whole numbers. You must be careful, though, to keep all decimal points in a straight line.

PART I--Add decimals

Add each column of numbers, carrying when necessary. Place a decimal point in the sum directly under the decimal points above.

EXAMPLES:

$$\begin{array}{r} 0.26 \\ +\,0.168 \\ \hline 0.428 \end{array} \qquad \begin{array}{r} 4.607 \\ +\,0.408 \\ \hline 5.015 \end{array}$$

A. $$\begin{array}{r} 0.024 \\ +\,0.165 \\ \hline \end{array}$$

B. $$\begin{array}{r} 0.873 \\ +\,0.199 \\ \hline \end{array}$$

C. $$\begin{array}{r} 4.6 \\ +\,4.62 \\ \hline \end{array}$$

D. $$\begin{array}{r} 0.0003 \\ +\,0.0099 \\ \hline \end{array}$$

E. $$\begin{array}{r} 8.69 \\ 3.07 \\ +\,17.50 \\ \hline \end{array}$$

F. $$\begin{array}{r} 4.612 \\ 0.958 \\ +\,0.885 \\ \hline \end{array}$$

G. $$\begin{array}{r} 5.29 \\ 4.38 \\ +\,9.62 \\ \hline \end{array}$$

H. $$\begin{array}{r} 72.24 \\ 16.38 \\ +\,92.37 \\ \hline \end{array}$$

I. $$\begin{array}{r} 1986.45 \\ 312.45 \\ +\,1000.98 \\ \hline \end{array}$$

J. $$\begin{array}{r} 4937.23 \\ 4980.47 \\ 10234.97 \\ +\ \ 9872.21 \\ \hline \end{array}$$

K. $$\begin{array}{r} 0.52802 \\ 0.34007 \\ 0.00321 \\ +\,0.00009 \\ \hline \end{array}$$

L. $$\begin{array}{r} 15.125 \\ 4.625 \\ 20.125 \\ +\,16.125 \\ \hline \end{array}$$

PART II--Subtract decimals

Rewrite each of the following problems in column form and subtract. Check your work.

A. 868.87 – 516.89 = ______________

ASSIGNMENT SHEET #10

B. 567 – 19.856 = ______________

C. 198 – 56.987 = ______________

D. 567.94 – 59.78 = ______________

E. $815.23 – $65.98 = ______________

F. $20.03 – $15.88 = ______________

G. 694.7 – 24.3 = ______________

H. 5,000 – 892.66 = ______________

ASSIGNMENT SHEET #10

I. $15 – $12.53 = ________________

J. 219.3 – 0.085 = ________________

PART III--Multiply decimals

You must be careful where you place the decimal point when you multiply numbers containing decimals. The number of decimal places in an answer must equal the total number of decimal places in the numbers that you multiplied.

EXAMPLE:

```
  16.11  -- 2 decimal places
 x  2.2  - 1 decimal place
 ------
   3222
  3222
 ------
 35.442  -- 3 decimal places in answer
```

Rewrite the following problems in column form and multiply. Locate the decimal point correctly in the product.

A. 2.54 x 3.1 = ________________

B. 120 x 0.33 = ________________

C. 2.25 x 0.51 = ________________

ASSIGNMENT SHEET #10

D. 35 x 8.5 = ______________

E. 26.4 x 3.8 = ______________

F. 7.02 x 0.92 = ______________

G. 0.83 x 0.55 = ______________

H. 28.2 x 0.9 = ______________

I. 0.069 x 0.01 = ______________

J. 7.52 x 3.01 = ______________

ASSIGNMENT SHEET #10

PART IV--Divide decimals

Division with decimals is like division with whole numbers. However, before you begin to divide, you must decide where the decimal point should be placed in the number.

First study the number by which you are dividing. If that number is a decimal, move the decimal point to the right so that you change the decimal to a whole number. Then move the decimal point the same number of places to the right in the number into which you are dividing.

EXAMPLES: 1. Decimal point moved 1 place in both numbers.

$$\underset{\wedge}{.2}\,\overline{)\,\underset{\wedge}{.\overset{\cdot}{4}}} \qquad\qquad \begin{array}{r} 2. \\ 2.\,\overline{)\,4.} \\ \underline{4} \\ 0 \end{array}$$

2. Decimal point moved 2 places in both numbers.

$$\underset{\wedge}{.14}\,\overline{)\,14.0\underset{\wedge}{\overset{\cdot}{2}}\,8} \qquad\qquad \begin{array}{r} 100.2 \\ 14.\,\overline{)\,1402.8} \\ \underline{14} \\ 0028 \\ \underline{28} \\ 0 \end{array}$$

3. Decimal point moved 1 place in both numbers; note that a zero had to be added.

$$\underset{\wedge}{1.3}\,\overline{)\,26.\underset{\wedge}{\overset{\cdot}{0}}} \qquad\qquad \begin{array}{r} 20. \\ 13.\,\overline{)\,260.} \\ \underline{26} \\ 0 \end{array}$$

4. No decimal point was moved to the right because 3 is already a whole number.

$$3\,\overline{)\,\overset{\cdot}{.}6} \qquad\qquad \begin{array}{r} .2 \\ 3\,\overline{)\,.6} \\ \underline{6} \\ 0 \end{array}$$

ASSIGNMENT SHEET #10

Divide the following problems. Show your work. Check your answers.

A. 4.5 ÷ 0.5 = ______

B. 4.96 ÷ 0.4 = ______

C. 19.8 ÷ 0.6 = ______

D. 10.71 ÷ 0.07 = ______

E. 0.225 ÷ 0.15 = ______

F. 1.7608 ÷ 0.0062 = ______

ASSIGNMENT SHEET #10

G. $0.48 \div 0.6 =$ ______

H. $0.125 \div 0.25 =$ ______

I. $0.9 \div 0.003 =$ ______

J. $1.16 \div 2.9 =$ ______

BASIC MATH
UNIT III

ASSIGNMENT SHEET #11--CONVERT FRACTIONS TO DECIMALS AND PERCENTAGES; CONVERT PERCENTAGES TO FRACTIONS AND DECIMALS

NAME ______________________ SCORE __________

In working with materials and amounts, percentage is often useful in simplifying practical problems. Percent means "per hundredths." Five percent means "five one-hundredths" and may be written three ways: 5/100, 0.05, and 5%. All have the same mathematical value.

Part I--Write fractions as decimals and percentages

A. Express each of the following fractions as a decimal.

EXAMPLE: $\frac{1}{5}$

$$\begin{array}{r} 0.20 \\ 5\overline{)1.00} \\ \underline{1\,0} \\ 0 \\ \underline{0} \end{array}$$

1. $\frac{1}{8}$ = ______

2. $\frac{1}{4}$ = ______

3. $\frac{1}{2}$ = ______

4. $\frac{3}{4}$ = ______

5. $\frac{5}{8}$ = ______

B. Express each fraction as a percentage.

(NOTE: Round off percentage to nearest tenth.)

EXAMPLE: $\frac{3}{7}$

$$\begin{array}{r} 0.428 \\ 7\overline{)3.000} \\ \underline{28} \\ 20 \\ \underline{14} \\ 60 \\ \underline{56} \\ 4 \end{array} = 0.429 = 42.9\%$$

1. $\frac{1}{4}$ = ______

2. $\frac{2}{9}$ = ______

3. $\frac{7}{10}$ = ______

4. $\frac{3}{4}$ = ______

5. $\frac{2}{2}$ = ______

ASSIGNMENT SHEET #11

PART II--Express percentages as fractions and decimals

A. Express each of the following percentages as a fraction.

1. 50% = ____________
2. 25% = ____________
3. 33.3% = ____________
4. 36% = ____________
5. 28% = ____________

B. Express each of the following percentages as a decimal.

1. 47% = ____________
2. 15% = ____________
3. 33.3% = ____________
4. 62% = ____________
5. 75% = ____________

PART III--Solve percentage problems

A. What does it mean to say 100 percent of the work is completed? ____________

____

B. There are usually 100 tools in the tool crib. Fourteen of them are missing. What percent of the tools are missing? ____________________________

C. If 14 of the tools are missing in the above problem, how many are present? ________

What percent are present? ____________________________

D. There are 100 bolts in a box. Twenty-five bolts are what percent of the bolts in the box? ____________________________

Five bolts are what percent of the bolts in the box? ________________

E. If 11% of the students in a school are absent, what percent are present? __________

ASSIGNMENT SHEET #11

PART IV--Find percentages of whole numbers

A. Solve each of the following problems.

1. 3% of 72 is what number? ____________
2. 5% of 18 is what number? ____________
3. What number is 33.3% of 96? ____________
4. 40% of 125 is what number? ____________
5. 68% of 63.5 is what number? ____________

B. Solve the following word problems.

1. There are 20 students in a class. Sixty percent of the students are boys.

   How many are boys? ______________________________

2. One day 5% of the 20 operators in Mr. Moore's group made perfect time completing a job. How many operators made perfect time? ____________________

ASSIGNMENT SHEET #11

3. Contractor McGill bought a new compressor, regularly selling for $120, at a sale and saved 20%. How much money did he save? ____________________

BASIC MATH
UNIT III

ASSIGNMENT SHEET #12--SOLVE MIX RATIO PROBLEMS

NAME ______________________________ SCORE ______________

As an equipment operator you will have to figure mix ratios and combine materials for fueling equipment, spraying, concrete repairs, and ice control.

Solve mix ratio problems.

A. Given 300 cu yd of sand, you are to mix sand and salt to a ratio of 3:1. How much salt will you need?

______________________ cu yd of salt

B. Given 90 cu yd of aggregate, how much sand will you need to mix a 3:2 ratio of sand and aggregate?

______________________ cu yd of sand

C. You are to mix 1/4" aggregate and 1/2" aggregate to a ratio of 3:2. How much 1/4" aggregate will you need if you have 150 cu yd of 1/2" aggregate?

______________________ cu yd of 1/4" aggregate

D. Given 300 gallons of asphalt concrete, mix asphalt concrete and solvent to a ratio of 75:25. How much solvent will you need?

______________________ gal of solvent

E. The fuel mixture ratio of gasoline to two-cycle engine oil is 20:1 for your chain saw. How much oil will you add to 5 gal of gas?

______________________ qt of oil

F. At a 20:1 ratio of gasoline to two-cycle engine oil, how much oil is added to 1 gal of gas?

______________________ oz of oil

G. The ratio of an industrial strength cleaner in water is 6 parts cleaner to 100 parts water. You estimate the job will take 15 gallons of water. How much cleaner will you add?

______________________ gal cleaner

H. The maintenance crew is having a fish fry. You are to make the tartar sauce of pickle relish, mayonnaise, and lemon juice at a ratio of 1.5:2:0.2. You estimate one 32-oz jar of mayonnaise will be enough. How much pickle relish and lemon juice will you mix with the mayonnaise?

______________________ oz pickle relish

______________________ oz lemon juice

BASIC MATH
UNIT III

ASSIGNMENT SHEET #13--SOLVE SLOPE RATIO PROBLEMS

NAME ______________________________ SCORE ______________

The operator needs to figure slope ratios for cutting slopes and for operating on slopes. Steeper slopes require additional safety procedures to keep equipment upright.

PART I

Find the slope ratio in feet and in inches. Convert distances to like terms where needed. Round off to the nearest hundredth.

V = vertical distance

H = horizontal distance

DISTANCES		RATIO (FEET)	RATIO (INCHES)	SLOPE RATIO
A.	V = 12 ft, H = 24 ft	________	— —	________
B.	H = 15 in , V = 5 in	— —	________	________
C.	H = 5 ft, V = 0.05 ft	________	________	________
D.	V = 1 in , H = 3 ft	________	________	________
E.	H = 12 ft, V = 4 in	________	________	________
F.	V = 2 in , H = 8 ft	________	________	________
G.	V = 18 in , H = 30 ft	________	________	________
H.	H = 18 ft, V = 5 in	________	________	________

PART II

Find the vertical distance.

	SLOPE RATIO	HORIZONTAL DISTANCE	VERTICAL DISTANCE
A.	3:1	24 ft	____________ft
B.	14:1	224 in	____________in
C.	6.5:1	26 ft	____________ft
D.	32:5	112 ft	____________ft
E.	4.5:1	18 ft	____________ft
F.	25:1	100 ft	____________ft

ASSIGNMENT SHEET #13

PART III

Find the horizontal distance.

	SLOPE RATIO	VERTICAL DISTANCE	HORIZONTAL DISTANCE
A.	25:1	0.5 ft	____________ ft
B.	16:3	9 in	____________ ft
C.	40:1	4 ft	____________ ft
D.	18:4	36 ft	____________ ft
E.	16:1	7.5 ft	____________ ft
F.	25:3	3 ft	____________ ft
G.	6:1	6 ft 4 in	____________ ft
H.	20:1	7 ft 11 in	______ ft ______ in

BASIC MATH
UNIT III

ASSIGNMENT SHEET #14--SOLVE PROBLEMS USING MEASURE AND VOLUME

NAME ______________________________ SCORE ______________

Maintenance operations involve the use of many different materials. Any application requires the correct amounts. An error in estimating the amount of fill material needed may waste hours if a truck has to return for an unscheduled reloading. Knowing how to compute units of measure and basic volumes is a skill you will use repeatedly on the job. Refer to Section XXVI in the Information Sheet for measures and equivalents.

All quantities or distances in a problem must be expressed in *like terms.*

EXAMPLES: Feet + feet, inches ÷ inches, gallons + gallons, yd x yd

You cannot perform any mathematical operations with unlike terms such as quarts and gallons. You must convert one of the quantities to the same measure as the other or others.

(NOTE: It is usually better to convert larger units to smaller units; but if the problem is simple enough, it is faster and easier to convert from smaller units to larger units.)

Multiply to convert larger units to smaller units.

EXAMPLE: Convert 8 gallons to quarts.
8 x 4 = 32 quarts

Divide to convert from smaller units to larger units.

EXAMPLE: Convert 32 quarts to gallons.
32 ÷ 4 = 8 gallons

PART I--Conversions

Use Section XXVI of the Information Sheet as needed to convert the following measures. Round off answers to the nearest tenth.

A. 48 in = __________ ft

B. 312 ft = __________ yd

C. 8 cu yd = __________ cu ft

D. 7 sq yd = __________ sq ft

E. 11 gal = __________ qt

F. 6 pt = __________ qt

G. 3/4 mile = __________ ft

H. 1260 sq ft = __________ sq yd

I. 246 sq in = __________ sq ft

J. 5120 acres = __________ sq mi

ASSIGNMENT SHEET #14

K. 128 oz = __________ qt

L. 396 in = __________ yd

M. How many quarts are in a 55-gal drum? ____________________

N. How many cubic yards of sand are in 3,078 cu ft? ____________________

PART II--Basic formulas

Area expressed in square units equals length times width: $A = L \times W$

Volume expressed in cubic units equals length times width times height: $V = L \times W \times H$

Area of triangle expressed in square units equals one-half base times height: $A = 1/2B \times H$

A. Figure surface area

1. 24' x 18' __________ sq ft
2. 13 in x 2 1/2 ft __________ sq ft
3. 8 yd x 4 ft 6 in __________ sq ft
4. 6 ft x 19 ft __________ sq ft

B. Figure volume

1. 7 ft x 2 ft x 1 ft __________ cu ft
2. 4 in x 2 in x 1/2 in __________ cu in
3. 6 ft x 12 ft x 4 in __________ cu ft
4. 1/2 ft x 3 in x 2 ft __________ cu in

C. Figure the area of triangles

1. Base = 16 in, height = 20 in __________ sq in or __________ sq ft
2. Height = 3 ft, base = 8 ft __________ sq ft or __________ sq yd
3. Height = 12 inches, base = 18 in __________ sq in or __________ sq ft
4. Base = 320 yd; height 180 yd __________ sq yd or __________ acres

ASSIGNMENT SHEET #14

PART III--Problems

Read the problems carefully to determine what is required and what mathematical operations are needed.

EXAMPLE: How many cubic yards of concrete will be required to make a pavement patch 12 feet long, 6 feet wide, and 9 inches deep?

(a) The question asks for volume.

(b) The formula for volume is L x W x H.

(c) The problem is stated in feet and inches; you will have to convert inches to feet (12 in = 1 ft).

(d) The answer is in cubic yards; you will have to convert cubic feet to cubic yards (27 cu ft = 1 cu yd).

Write out the formula; determine the length, width, and height; and calculate the volume.

EXAMPLE:

$$9 \text{ in} = 0.75 \text{ ft (conversion)}$$

$$V = L \times W \times H$$

$$V = 12 \times 6 \times 0.75$$

$$= 72 \times 0.75$$

$$= 54 \text{ cu ft}$$

$$= 54 \text{ cu ft} \div \frac{27 \text{ cu ft}}{\text{cu yd}}$$

$$= \frac{54 \text{ cu ft}}{1} \times \frac{\text{cu yd}}{27 \text{ cu ft}}$$

$$= \frac{54}{27} \text{ cu yd}$$

$$= 2 \text{ cu yd}$$

ASSIGNMENT SHEET #14

Solve the following problems. Round off answers to the nearest tenth. Show your work.

A. One cubic yard of aggregate weighs 2,550 lb. How many tons would 10 cubic yards weigh?

(NOTE: 1 ton = 2,000 lb)

__________ tons

B. What is the surface area of a failure 3 ft by 6 ft?

__________ sq ft

C. What is the surface area of a failure 2 ft 8 in by 1 ft 6 in ?

__________ sq ft

ASSIGNMENT SHEET #14

D. How many cubic feet of concrete will be required to make a pavement patch 8 feet long, 7 feet wide and 6 inches deep?

____________ cu ft

E. How many cubic yards of concrete will be required to replace a slab 15 in deep, 12 ft long and 8 ft wide?

____________ cu yds

F. A stockpile of material is in a triangular shape 12 ft high and 8 ft wide and 150 ft long. How many cubic yards of material are in the stockpile?

____________ cu yd

ASSIGNMENT SHEET #14

G. How many square feet have to be painted on a building 20 feet long on each side and 14 feet high if you paint all four sides? If a gallon of paint covers 350 square feet, how many gallons are required?

__________ sq ft __________ gal of paint

H. How many acres of right-of-way are in an area 15 feet wide and 7 miles long?

__________ acres

I. You are resurfacing a section of roadway 12 feet wide and 1/2 mile long. What is the surface area to be sprayed with asphaltic oil? If a 4-inch layer of aggregate is laid on top of the oil, how many cubic yards of aggregate will be required? If a heavy-duty dump truck carries 18 cubic yards, how many truckloads will be required?

1.__________ sq ft of road surface

2.__________ cu yd of aggregate

3.__________ truckloads

ASSIGNMENT SHEET #14

J. A tractor tire tube is to be immersed in water to locate a leak. The tank is 6 ft by 6 ft. How much water will be required to fill it to a depth of 3 ft?

____________ gal

BASIC MATH
UNIT III

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A.
1. 8
2. 11
3. 7
4. 10
5. 8
6. 5
7. 4
8. 6
9. 2
10. 11
11. 16
12. 11
13. 7
14. 17

B.
1. 157
2. 177
3. 207
4. 157
5. 164
6. 151
7. 191
8. 148
9. 174
10. 135

C.
1. 2,606
2. 2,283
3. 2,269
4. 3,387
5. 1,838
6. 2,946
7. 941
8. 1,471

D. 20 miles

E. 13 inches

F. 170 pounds

G. 115 gallons

H. 1,140 feet

I. 1,299 hours

J. 1,748 sq ft

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #2

A. 1. 5
2. 1
3. 3
4. 3
5. 2
6. 6
7. 1

B. 1. 19
2. 27
3. 1,448
4. 2,639

C. 1. 99
2. 327
3. 482
4. 14

D. 1. 48
2. 33
3. 38
4. 56

E. 1. 32
2. 126
3. 178
4. 199

ANSWERS TO ASSIGNMENT SHEETS

F.
1. 4,528
2. 156
3. 1,830
4. 5,338

G. 2 bolts

H. 21 inches

I. 7 feet

J. 6,084 linear feet

Assignment Sheet #3

A.
1. 12
2. 0
3. 18
4. 14
5. 8
6. 24
7. 20

B.
1. 84
2. 265
3. 624
4. 3,515
5. 1,977

C.
1. 2,394
2. 6,460
3. 1,888
4. 4,032
5. 4,672
6. 4,482

D.
1. 7,030
2. 5,130
3. 2,881
4. 4,928
5. 6,314
6. 6,633

ANSWERS TO ASSIGNMENT SHEET

E.
1. 308,024
2. 929,071
3. 50,304
4. 274,995
5. 640,791
6. 395,605

F. 1,466,088 pounds

G. 4,732 cubic yards

H. 27 square feet

I. 72 square feet

J. 630 tons

Assignment Sheet #4

A.
1. 2
2. 3
3. 45
4. 600
5. 1
6. 4
7. 12
8. 9

B.
1. 2
2. 3
3. 3
4. 4
5. 12
6. 8
7. 327, R 5
8. 124, R 51
9. 186, R 4

C. 381 miles

D. 151.2 days

Assignment Sheet #5

A.
1. $\frac{13}{4}$
2. $\frac{9}{2}$
3. $\frac{22}{3}$
4. $\frac{17}{2}$
5. $\frac{20}{3}$
6. $\frac{26}{5}$
7. $\frac{14}{3}$
8. $\frac{57}{7}$
9. $\frac{46}{5}$
10. $\frac{50}{3}$
11. $\frac{5}{2}$
12. $\frac{14}{4}$
13. $\frac{31}{4}$
14. $\frac{29}{3}$
15. $\frac{17}{3}$
16. $\frac{49}{8}$
17. $\frac{15}{4}$
18. $\frac{34}{5}$
19. $\frac{13}{3}$
20. $\frac{9}{5}$

ANSWERS TO ASSIGNMENT SHEETS

B.

1. $3\frac{1}{5}$
2. $2\frac{2}{5}$
3. $5\frac{2}{3}$
4. $2\frac{2}{3}$
5. $4\frac{1}{2}$
6. $1\frac{2}{3}$
7. $3\frac{1}{2}$
8. $2\frac{1}{4}$
9. $1\frac{1}{16}$
10. $2\frac{1}{5}$
11. $1\frac{6}{13}$
12. $1\frac{1}{7}$
13. $2\frac{11}{32}$
14. $1\frac{7}{17}$
15. $1\frac{4}{9}$
16. $1\frac{3}{4}$
17. $1\frac{3}{6}$
18. $1\frac{1}{3}$
19. $3\frac{3}{4}$
20. $2\frac{2}{7}$

Assignment Sheet #6

A. $\frac{1}{3}$
B. $\frac{1}{3}$
C. $\frac{2}{3}$
D. $\frac{3}{5}$
E. $\frac{1}{4}$
F. $\frac{3}{8}$
G. $\frac{5}{7}$
H. $\frac{1}{2}$
I. $\frac{3}{4}$
J. $\frac{1}{2}$
K. 1
L. $\frac{2}{3}$
M. $\frac{1}{3}$
N. $\frac{1}{2}$
O. $\frac{5}{6}$
P. $\frac{1}{2}$
Q. $\frac{2}{3}$
R. $\frac{1}{3}$
S. 1
T. $\frac{3}{4}$

Assignment Sheet #7

PART I

A.
1. 6
2. 8
3. 9
4. 10

B.
1. 8
2. 20
3. 28
4. 10

C.
1. 3
2. 3
3. 3
4. 18

D.
1. 5
2. 5
3. 7
4. 9

PART II

A.
1. LCD = 9
2. $\frac{6}{9}$
3. $\frac{7}{9}$

ANSWERS TO ASSIGNMENT SHEETS

B. 1. LCD = 24

2. $\frac{21}{24}$

3. $\frac{20}{24}$

C. 1. LCD = 24

2. $\frac{8}{24}$

3. $\frac{22}{24}$

4. $\frac{9}{24}$

D. 1. LCD = 56

2. $\frac{8}{56}$

3. $\frac{35}{56}$

E. 1. LCD = 16

2. $\frac{1}{16}$

3. $\frac{6}{16}$

4. $\frac{12}{16}$

F. 1. LCD = 36

2. $\frac{10}{36}$

3. $\frac{27}{36}$

4. $\frac{4}{36}$

Assignment Sheet #8

PART I

A. $\frac{11}{12}$

B. $1\frac{7}{12}$

C. $1\frac{11}{20}$

D. $1\frac{11}{24}$

E. $1\frac{8}{63}$

F. $\frac{38}{45}$

G. $1\frac{5}{24}$

H. $1\frac{4}{15}$

I. $1\frac{5}{8}$

J. $1\frac{3}{16}$

K. $2\frac{2}{5}$

L. $1\frac{5}{36}$

M. $1\frac{5}{8}$

N. $1\frac{1}{40}$

ANSWERS TO ASSIGNMENT SHEETS

PART II

A. $\frac{1}{12}$

B. $\frac{1}{6}$

C. $\frac{5}{24}$

D. $\frac{17}{40}$

E. $\frac{23}{60}$

F. $\frac{7}{30}$

G. $\frac{5}{24}$

H. $\frac{19}{63}$

I. $\frac{13}{72}$

J. $\frac{1}{48}$

PART III

A. $\frac{3}{8}$

B. $\frac{15}{128}$

C. $3\frac{3}{8}$

D. $3\frac{1}{4}$

E. $\frac{7}{12}$

F. $1\frac{1}{2}$

G. $\frac{1}{24}$

H. $16\frac{27}{32}$

PART IV

A. $1\frac{1}{6}$

B. $\frac{3}{8}$

C. $1\frac{1}{24}$

D. $4\frac{2}{3}$

E. $2\frac{7}{10}$

F. $9\frac{1}{6}$

G. $\frac{3}{4}$

H. $13\frac{1}{3}$

I. $8\frac{1}{4}$

J. $42\frac{2}{3}$

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #9

A.	1.	g	6.	b
	2.	j	7.	c
	3.	d	8.	f
	4.	a	9.	h
	5.	i	10.	e
B.	1.	63.9	6.	38.95
	2.	5.93	7.	38.095
	3.	5.093	8.	42.3
	4.	5.0093	9.	402.3
	5.	3.825	10.	897.00097

Assignment Sheet #10

PART I

A.	0.189	G.	19.29
B.	1.072	H.	180.99
C.	9.22	I.	3,299.88
D.	0.0102	J.	30,024.88
E.	29.26	K.	0.87139
F.	6.455	L.	56.000

PART II

A.	351.98	F.	$4.15
B.	547.144	G.	670.4
C.	141.013	H.	4107.34
D.	508.16	I.	$2.47
E.	$749.25	J.	219.215

ANSWERS TO ASSIGNMENT SHEETS

PART III

A. 7.874

B. 39.6

C. 1.1475

D. 297.5

E. 100.32

F. 6.4584

G. 0.4565

H. 25.38

I. 0.00069

J. 22.6352

PART IV

A. 9

B. 12.4

C. 33

D. 153

E. 1.5

F. 284

G. 0.8

H. 0.5

I. 300

J. 0.4

Assignment Sheet #11

PART I

A. 1. 0.125
   2. 0.25
   3. 0.5
   4. 0.75
   5. 0.625

B. 1. 25%
   2. 22.2%

ANSWERS TO ASSIGNMENT SHEETS

3. 70%
4. 75%
5. 100%

PART II

A.
1. 1/2
2. 1/4
3. 1/3
4. 9/25
5. 7/25

B.
1. 0.47
2. 0.15
3. 0.333
4. 0.62
5. 0.75

PART III

A. All work is completed

B. 14%

C. 86, 86%

D. 25%, 5%

E. 89%

PART IV

A.
1. 2.16
2. 0.9
3. 32
4. 50
5. 43.18

ANSWERS TO ASSIGNMENT SHEETS

B. 1. 12

2. 1

3. $24.00

Assignment Sheet #12

A. 100 cu yd of salt

B. 135 cu yd of sand

C. 225 cu yd of 1/4" aggregate

D. 100 gal of solvent

E. 1 qt of oil

F. 6.4 oz of oil

G. 0.9 gal cleaner

H. 24 oz pickle relish, 3.2 oz lemon juice

Assignment Sheet #13

PART I

	RATIO (FEET)	RATIO (INCHES)	SLOPE RATIO
A.	24:12	— —	2:1
B.	— —	15:5	3:1
C.	5:0.05	60:0.6	100:1
D.	3:0.08	36:1	36:1
E.	12:0.33	144:4	36:1
F.	8:0.17	96:2	48:1
G.	30:1.5	360:18	20:1
H.	18:0.42	216:5	43.2:1

PART II

A. 8 ft

B. 16 in

ANSWERS TO ASSIGNMENT SHEETS

C. 4 ft

D. 17.5 ft

E. 4 ft

F. 4 ft

PART III

A. 12.5 ft

B. 4 ft

C. 160 ft

D. 162 ft

E. 120 ft

F. 25 ft

G. 38 ft (or 37.98 ft if decimals were used)

H. 158 ft 4 in

Assignment Sheet #14

PART I

A. 4 ft

B. 104 yd

C. 216 cu ft

D. 63 sq ft

E. 44 qt

F. 3 qt

G. 3,960 ft

H. 140 sq yd

I. 1.7 sq ft

J. 8 sq mi

K. 4 qt

L. 11 yd

ANSWERS TO ASSIGNMENT SHEETS

M. 220 qt

N. 114 cu yd

PART II

A. 1. 432 sq ft
   2. 2.7 sq ft
   3. 108 sq ft
   4. 114 sq ft

B. 1. 14 cu ft
   2. 4 cu in
   3. 24 cu ft
   4. 432 cu in

C. 1. 160 sq in , 1.11 sq ft
   2. 12 sq ft, 1.33 sq yd
   3. 108 sq in , 0.75 sq ft
   4. 28,800 sq yd, 5.95 acres

PART III

A. 12.8 tons

B. 18 sq ft

C. 4 sq ft

D. 28 cu ft

E. 4.4 cu yd

F. 266.7 cu yd

G. 1120 sq ft, 3.2 gal of paint

H. 12.7 acres

ANSWERS TO ASSIGNMENT SHEETS

I. 1. 31,680 sq ft of road surface

(NOTE: Answers to 2 and 3 will vary significantly according to how the student converted the surface area figure.)

Converted to inches or used fractions

2. 391.1 cu yd of aggregate
3. 21.7 (22) truckloads

Converted to feet, using 0.3

2. 352 cu yd of aggregate
3. 19.6 (20) truckloads

Converted to feet, using 0.33

2. 387.2 cu yd of aggregate
3. 21.5 (22) truckloads

J. 810 gal

BASIC MATH
UNIT III

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with basic math to their correct definitions. Write the correct numbers in the blanks. Terms and definitions are continued on the next page.

_____a. Mark made to indicate where something is to be inserted

_____b. To solve by mathematical process

_____c. "Per hundred"; division into 100 equal parts; another way of expressing a fraction whose denominator is 100

_____d. Bottom number of fraction; tells into how many equal parts the whole is divided

_____e. Measure of a flat surface having length and width; expressed in square units

_____f. Mathematical proposition

_____g. Number being divided

_____h. Outer limits or boundary of a space

_____i. Abbreviated process of adding a number to itself a specified number of times

_____j. First integer, equal to 1

_____k. Space occupied by a body having length, height, and width; expressed in cubic units

_____l. Fractions based on the number 10; not written as common fractions

_____m. Comparison of one quantity with another like quantity or value using the : symbol or division bar

_____n. Combining of two or more numbers

_____o. Positive or negative whole number

_____p. Opposite operation of multiplication

1. Dividend
2. Area
3. Percent
4. Unit
5. Integer
6. Calculate
7. Ratio
8. Perimeter
9. Caret (∧)
10. Division
11. Denominator
12. Problem
13. Volume
14. Decimals
15. Multiplication
16. Addition

TEST

______q. Describes the relationship between the horizontal distance and the vertical distance of a slope, expressed in feet

______r. Top number of the fraction; tells how many equal parts of the whole are being considered

______s. Answer to a division problem

______t. Finding the difference between two numbers

______u. Number by which you divide

______v. Any one of the ten symbols, 0 to 9, by which all numbers may be expressed

______w. Part of a whole; represents one or more equal parts of a unit

______x. Answer to a multiplication problem

17. Numerator
18. Quotient
19. Digit
20. Product
21. Subtraction
22. Fraction
23. Divisor
24. Slope ratio

2. Match symbols used in math problems to their correct names. Write the correct numbers in the blanks provided.

______a. Addition

______b. Subtraction

______c. Division

______d. Multiplication

______e. Ratio

______f. Equal

______g. Decimal

______h. Percent

______i. Caret

1. $\div$ $\overline{)}$
2. $\cdot$
3. $=$
4. %
5. :
6. $+$
7. $\wedge$
8. $\times$
9. $-$

3. Solve the following addition problems.

a.	b.	c.	d.	e.
1	5	35	114	2706
9	7	10	241	4521
3	8	25	305	5134
+ 5	4	+ 70	+ 422	+ 7250
	+ 1			

TEST

4. Solve the following subtraction problems.

a. 9 - 3
b. 8 - 2
c. 44 - 4
d. 89 - 7
e. 87 - 52

f. 342 - 128
g. 1711 - 504
h. 2990 - 2837
i. 39082 - 8151
j. 94584 - 2893

5. Solve the following multiplication problems.

a. 7 x 5
b. 10 x 9
c. 212 x 3
d. 42 x 21
e. 510 x 34

f. 122 x 15
g. 178 x 141
h. 428 x 319
i. 1147 x 319
j. 1215 x 500

6. Solve the following division problems. Include the remainder, if any, as part of your answer.

a. 5)40
b. 22)88
c. 42)320

d. 330)990
e. 452)1087
f. 641)16754

7. Distinguish among types of fractions. Write a "P" in the blanks before proper fractions, an "I" before improper fractions, and an "M" in the blanks before mixed fractions.

_____a. 1/3

_____b. 8 1/5

_____c. 7/7

_____d. 15 2/3

_____e. 5 2/7

_____f. 10/25

_____g. 2/5

_____h. 6 1/2

_____i. 1/4

_____j. 99/1

TEST

8. Convert the following mixed numbers to improper fractions.

a. 3 1/2 = ____________________

b. 4 2/4 = ____________________

c. 3 6/9 = ____________________

d. 12 4/6 = ____________________

e. 13 13/39 = ____________________

9. Reduce the following fractions to lowest terms.

a. 4/10 = ____________________

b. 8/12 = ____________________

c. 7/14 = ____________________

d. 8/14 = ____________________

e. 12/50 = ____________________

f. 4/16 = ____________________

g. 2/16 = ____________________

h. 8/10 = ____________________

i. 12/16 = ____________________

j. 121/132 = ____________________

10. Add the following fractions. Reduce to lowest terms.

a. $\frac{1}{8} + \frac{5}{8} =$ ____________________

b. $\frac{1}{16} + \frac{15}{16} =$ ____________________

c. $\frac{2}{3} + \frac{3}{3} =$ ____________________

d. $\frac{1}{2} + \frac{4}{8} =$ ____________________

e. $\frac{4}{5} + \frac{2}{3} =$ ____________________

f. $\frac{7}{8} + \frac{6}{9} =$ ____________________

g. $2\frac{1}{3} + 7\frac{1}{7} =$ ____________________

h. $3\frac{2}{4} + 16\frac{1}{5} =$ ____________________

i. $4\frac{2}{7} + 8\frac{2}{3} =$ ____________________

j. $5\frac{1}{5} + 6\frac{2}{6} =$ ____________________

TEST

11. Find the lowest common denominator. Convert each fraction to its LCD equivalent.

a. 1) $\frac{7}{32}, \frac{5}{8}$ LCD = ______

2) $\frac{7}{32}$ = ______

3) $\frac{5}{8}$ = ______

b. 1) $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}$ LCD = ______

2) $\frac{1}{2}$ = ______

3) $\frac{2}{3}$ = ______

4) $\frac{3}{4}$ = ______

c. 1) $\frac{3}{16}, \frac{3}{4}, \frac{1}{8}$ LCD = ______

2) $\frac{3}{16}$ = ______

3) $\frac{3}{4}$ = ______

4) $\frac{1}{8}$ = ______

d. 1) $\frac{4}{5}, \frac{7}{8}, \frac{3}{4}$ LCD = ______

2) $\frac{4}{5}$ = ______

3) $\frac{7}{8}$ = ______

4) $\frac{3}{4}$ = ______

e. 1) $\frac{7}{8}, \frac{5}{6}$ LCD = ______

2) $\frac{7}{8}$ = ______

3) $\frac{5}{6}$ = ______

f. 1) $\frac{2}{3}, \frac{5}{6}, \frac{1}{2}$ LCD = ______

2) $\frac{2}{3}$ = ______

3) $\frac{5}{6}$ = ______

4) $\frac{1}{2}$ = ______

TEST

12. Subtract the following fractions. Reduce to lowest terms.

a. $\frac{4}{5} - \frac{3}{5} =$ ____________________

b. $\frac{6}{8} - \frac{2}{8} =$ ____________________

c. $\frac{9}{13} - \frac{4}{13} =$ ____________________

d. $\frac{3}{6} - \frac{1}{3} =$ ____________________

e. $\frac{3}{8} - \frac{1}{3} =$ ____________________

f. $\frac{14}{16} - \frac{7}{8} =$ ____________________

g. $2\frac{3}{4} - 1\frac{1}{4} =$ ____________________

h. $6\frac{1}{3} - 2\frac{1}{2} =$ ____________________

i. $9\frac{2}{5} - 4\frac{1}{2} =$ ____________________

j. $12\frac{6}{8} - 7\frac{1}{3} =$ ____________________

13. Multiply the following fractions. Reduce to lowest terms.

a. $\frac{1}{2} \times \frac{4}{5} =$ _____

b. $\frac{3}{4} \times \frac{3}{7} =$ _____

c. $\frac{9}{5} \times \frac{2}{3} =$ _____

TEST

d. $\frac{3}{4} \times 6\frac{1}{2} =$ ______

e. $6\frac{3}{4} \times 8\frac{3}{4} =$ ______

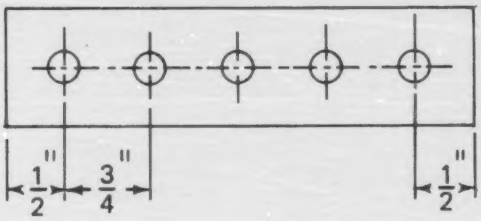
f. $7\frac{1}{3} \times 1\frac{1}{2} =$ ______

g. $\frac{77}{15} \times 5 =$ ______

h. A piece of sign post steel is 15 ft long. A section of the steel equal to 1/20 of its total length is cut off. How long is this piece? (Convert your answer to inches.)

______________________ in

i. The plate illustrated is to be drilled with five holes equally spaced. Find the length of the plate.



______________________ in

TEST

j. Two trucks are used to haul crushed rock. The larger truck hauls 3 1/2 cubic yards per load, and the other hauls 2 1/4 cubic yards per load. If each truck hauls 16 loads, what is the total quantity in cubic yards of crushed rock hauled?

______________ cu yd

14. Divide fractions. Reduce to lowest terms.

a. $\frac{3}{8} \div \frac{3}{4} =$ ______

b. $2\frac{1}{2} \div \frac{2}{3} =$ ______

c. $\frac{3}{4} \div 5 =$ ______

d. $4\frac{1}{3} \div \frac{3}{8} =$ ______

e. $5\frac{3}{8} \div 3\frac{1}{4} =$ ______

f. $6\frac{2}{3} \div 2 =$ ______

g. $1\frac{7}{9} \div 5\frac{1}{4} =$ ______

h. A truck is loaded with cartons, each weighing 1/20 ton. If the total weight of the cartons is 1 3/4 tons, how many cartons are on the truck?

______________ cartons

i. How many stakes 3/4 ft long can be cut from a piece of lumber 16 ft long? How much is left?

______________ stakes

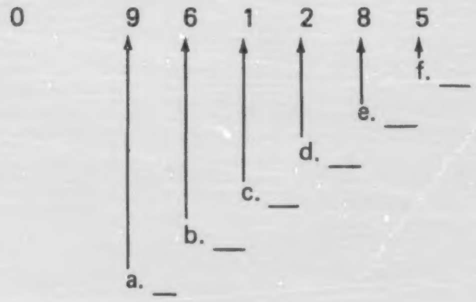
______________ left

j. If 1/9 cu yd of cement is needed in mixing one cu yd of concrete, how many cu yds of concrete can be mixed using 7/8 cu yd of cement?

______________ cu yd

TEST

15. Match each of the numerals in the decimal number 0.961285 with the correct place value name. Write the correct numbers in the blanks.



1. Hundredths
2. Hundred-thousandths
3. Tenths
4. Millionths
5. Ten-thousandths
6. Thousandths

16. Convert the following fractions to decimals.

a. $23\ \frac{3}{100}$ = ____________

b. $18\ \frac{3}{10}$ = ____________

c. $5\ \frac{5}{1000}$ = ____________

d. $8\ \frac{13}{100000}$ = ____________

e. $11\ \frac{24}{1000000}$ = ____________

17. Add the following decimals. Write in column form.

a. 3.5 + 5.1 + 7 = ______

b. 3.4 + 0.206 + 1.75 = ______

c. 6.86 + 0.0505 + 7.9 + 82 = ______

d. 57.78 + 0.22 + 0.003 + 74 = ______

e. 6,319 + 95.12 + 0.0713 + 321.07 = ______

TEST

18. Subtract the following decimals.

a. 6.103 – 2.209 = ________________

b. 5.400 – 2.322 = ________________

c. 7.38 – 0.063 = ________________

d. 0.835325 – 0.25 = ________________

e. 0.609375 – 0.359375 = ________________

19. Multiply the following decimals.

a. 2.6 x 4.7 = ________________

b. 0.119 x 0.05 = ________________

c. 9 x 0.8 = ________________

d. 9.5 x 0.76 = ________________

TEST

20. Divide the following decimals by decimals. Check your work.

a. $0.4\overline{)5.32}$ b. $0.6\overline{)83.4}$ c. $0.765 \div 0.5 =$ __________

d. $0.921 \div 0.3 =$ __________   e. $0.0225 \div 0.15 =$ __________

21. Divide the following whole numbers by decimals.

a. $24 \div 0.2 =$ ________________

b. $54 \div 0.09 =$ ________________

TEST

c. $63 \div 0.007 =$ ______________

d. $812 \div 0.058 =$ ________________

e. $4215 \div 0.040 =$ ________________

22. Convert the following fractions to decimals and percentages. Express percentages as fractions as needed.

			DECIMAL	PERCENTAGE
EXAMPLE:	$\frac{9}{16}$		0.5625	$56\frac{1}{4}\%$
a.	$\frac{1}{3}$	=	____________	________________
b.	$\frac{3}{25}$	=	____________	________________
c.	$\frac{7}{16}$	=	____________	________________

TEST

d. $\frac{2}{7}$ = ____________ ____________

e. $\frac{5}{6}$ = ____________ ____________

23. Convert the following percentages to fractions and decimals. Reduce fractions to lowest terms.

		FRACTIONS	DECIMALS
a.	12% =	____________	____________
b.	30% =	____________	____________
c.	45% =	____________	____________
d.	72% =	____________	____________
e.	250% =	____________	____________

24. Solve the following percentage problems.

   a. If a motor with 150 horsepower runs with 87% efficiency, how much horsepower does it deliver? ________________________

   b. If antifreeze evaporates 12% while in storage, how many gallons will be left of 2100 gallons placed in storage? ________________________

   c. If a contractor bought a tractor for $24,000 and sold it for $30,000, what was his percentage of profit? ________________________

25. Write common fractional and decimal equivalents in the blanks.

	FRACTION		DECIMAL
a.	____________	=	0.0625
b.	1/8	=	____________
c.	1/4	=	____________
d.	____________	=	0.375
e.	1/2	=	____________
f.	5/8	=	____________
g.	3/4	=	____________
h.	____________	=	0.875

TEST

26. Match standard measures to their equivalents. Write the correct numbers in the blanks. Some may be used more than once.

Linear measure

______a. 1,760 yd

______b. 3 ft

______c. 5,280 ft

______d. 12 in

1. 1 yd
2. 1 mile
3. 1 ft

Surface measure

______e. 4,840 sq yd

______f. 144 sq in

______g. 640 acres

______h. 9 sq ft

4. 1 acre
5. 1 sq yd
6. 1 sq ft
7. 1 sq mi

Cubic measure

______i. 1,728 cu in

______j. 27 cu ft

8. 1 cu ft
9. 1 cu yd

Liquid measure

______k. 2 pt

______l. 16 oz

______m. 30 gal

______n. 4 qt

______o. 55 gal

______p. 1 gal water

______q. 7 1/2 gal

10. 1 gal
11. 1 drum
12. 1 pt
13. 8 1/2 pounds
14. 1 qt
15. 1 cu ft
16. 1/2 drum

27. Write the basic formulas for surface area, area of a triangle, and volume.

a. Surface area ______________________________

b. Volume ______________________________

c. Area of a triangle ______________________________

TEST

28. Solve mix ratio problems.

    a. Chain saw fuel has a 20:1 ratio of gasoline to oil. How much oil will you add to 10 gallons of gasoline?

    ________________________ gal

    b. Given 600 cu yd of sand, you are to mix sand and salt in a 3:2 ratio. How much salt will you need?

    ________________________ cu yd salt

    c. The cement, sand, and aggregate ratio for a repair job is 2:2:1. You will use 40 cu ft of sand. How much cement and how much aggregate will be used?

    ________________________ cu ft of cement

    ________________________ cu ft of aggregate

    d. A cleaning agent requires an additive at a ratio of 15:2. If you store 45 gallons of cleaning agent, how many gallons of additive should also be stored?

    ________________________ gallons

    e. Given 70 cu yd of aggregate, how much sand will you need to mix a 3:2 ratio of sand and aggregate?

    ________________________ cu yd of sand

    f. If a gear ratio is 4:1, how many times does the small gear turn when the large gear makes 3 turns?

    ________________________ turns

29. Solve slope ratio problems. Round off answers to the nearest tenth.

    a. What is the slope ratio if the vertical distance is 4 feet and the horizontal distance is 140 feet?

    ____

    b. Find the vertical distance with a slope ratio of 4:1 and a horizontal distance of 100 ft.

    ________________________ ft

    c. Find the horizontal distance when the vertical distance is 3 ft and the slope ratio is 8:1.

    ________________________ ft

TEST

d. If the horizontal distance is 16 ft, and the vertical distance is 4 in, what is the slope ratio?

____

e. With a slope ratio 7.5:1 and a horizontal distance of 130 ft, what is the vertical distance?

______________________ ft

f. What is the slope ratio if the horizontal distance is 100 ft, and the vertical distance is 4 ft 6 in?

____

g. If the slope ratio is 32:1, and the vertical distance is 4 inches, what is the horizontal distance?

____

h. Find the vertical distance when the slope ratio is 4:1 and the horizontal distance is 36 ft.

______________________ ft

i. If the vertical distance is 2.5 ft and the horizontal distance is 100 ft, what is the slope ratio?

____

(NOTE: Test question 30 lists Assignment Sheet #14. It is an important part of this test. If it has not been completed, check with your instructor.)

30. Solve problems using measure and volume.

BASIC MATH
UNIT III

ANSWERS TO TEST

1. a. 9
   b. 6
   c. 3
   d. 11
   e. 2
   f. 12
   g. 1
   h. 8
   i. 15
   j. 4
   k. 13
   l. 14
   m. 7
   n. 16
   o. 5
   p. 10
   q. 24
   r. 17
   s. 18
   t. 21
   u. 23
   v. 19
   w. 22
   x. 20

2. a. 6
   b. 9
   c. 1
   d. 8
   e. 5
   f. 3
   g. 2
   h. 4
   i. 7

3. a. 18
   b. 25
   c. 140
   d. 1,082
   e. 19,611

ANSWERS TO TEST

4.	a.	6	f.	214		
	b.	6	g.	1,207		
	c.	40	h.	153		
	d.	82	i.	30,931		
	e.	35	j.	91,691		
5.	a.	35	f.	1,830		
	b.	90	g.	25,098		
	c.	636	h.	136,532		
	d.	882	i.	365,893		
	e.	17,340	j.	607,500		
6.	a.	8	c.	7, R 26	e.	2, R 183
	b.	4	d.	3	f.	26, R 88
7.	a.	P	f.	P		
	b.	M	g.	P		
	c.	I	h.	M		
	d.	M	i.	P		
	e.	M	j.	I		
8.	a.	7/2				
	b.	18/4				
	c.	33/9				
	d.	76/6				
	e.	520/39				

ANSWERS TO TEST

9. a. 2/5
   b. 2/3
   c. 1/2
   d. 4/7
   e. 6/25
   f. 1/4
   g. 1/8
   h. 4/5
   i. 3/4
   j. 11/12

10. a. 3/4
    b. 1
    c. 1 2/3
    d. 1
    e. 1 7/15
    f. 1 13/24
    g. 9 10/21
    h. 19 7/10
    i. 12 20/21
    j. 11 8/15

11. a. 1) LCD = 32
       2) 7/32
       3) 20/32
    b. 1) LCD = 12
       2) 6/12
       3) 8/12
       4) 9/12
    c. 1) LCD = 16
       2) 3/16
       3) 12/16
       4) 2/16

ANSWERS TO TEST

d. 1) LCD = 40
   2) 32/40
   3) 35/40
   4) 30/40

e. 1) LCD = 24
   2) 21/24
   3) 20/24

f. 1) LCD = 6
   2) 4/6
   3) 5/6
   4) 3/6

12. a. 1/5
    b. 1/2
    c. 5/13
    d. 1/6
    e. 1/24
    f. 0
    g. 1 1/2
    h. 3 5/6
    i. 4 9/10
    j. 5 5/12

13. a. 2/5
    b. 9/28
    c. 1 1/5
    d. 4 7/8
    e. 59 1/16
    f. 11
    g. 25 2/3
    h. 9 in
    i. 4 in
    j. 92 cu yd

ANSWERS TO TEST

14. a. 1/2
    b. 3 3/4
    c. 3/20
    d. 11 5/9
    e. 1 17/26
    f. 3 1/3
    g. 64/189
    h. 35 cartons
    i. 21 stakes, 4" left
    j. 7 7/8 cu yd

15. a. 3
    b. 1
    c. 6
    d. 5
    e. 2
    f. 4

16. a. 23.03
    b. 18.3
    c. 5.005
    d. 8.00013
    e. 11.000024

17. a.	b.	c.	d.	e.
3.5	3.400	6.8600	57.780	6319.0000
5.1	0.206	0.0505	00.220	0095.1200
7.0	1.750	7.9000	00.003	0000.0713
15.6	5.356	82.0000	74.000	0321.0700
		96.8105	132.003	6735.2613

ANSWERS TO TEST

18. a. 3.894
    b. 3.078
    c. 7.317
    d. 0.585325
    e. 0.25

19. a. 12.22
    b. 0.00595
    c. 7.2
    d. 7.22

20. a. 13.3
    b. 139
    c. 1.53
    d. 3.07
    e. 0.15

21. a. 120
    b. 600
    c. 9,000.
    d. 14,000.
    e. 105,375.

22. a. 0.3333; 33 1/3%
    b. 0.12; 12%
    c. 0.4375; 43 3/4%
    d. 0.2857; 28 57/100%
    e. 0.8333; 83 1/3%

ANSWERS TO TEST

23. a. 3/25; 0.12
    b. 3/10; 0.30
    c. 9/20; 0.45
    d. 18/25; 0.72
    e. 5/2; 2.50

24. a. 130.50 horsepower
    b. 1848 gallons
    c. 20%

25. a. 1/16
    b. 0.125
    c. 0.25
    d. 3/8
    e. 0.5
    f. 0.625
    g. 0.75
    h. 7/8

26. Linear measure
    a. 2
    b. 1
    c. 2
    d. 3

    Surface measure
    e. 4
    f. 6
    g. 7
    h. 5

    Cubic measure
    i. 8
    j. 9

ANSWERS TO TEST

Liquid measure

k. 14

l. 12

m. 16

n. 10

o. 11

p. 13

q. 15

27. a. A = L x W or Length x Width

b. V = L x W x H or Length x Width x Height

c. A = 1/2 B x H or 1/2 Base x Height

28. a. 1/2 gal

b. 400 cu yd salt

c. 40 cu ft of cement, 20 cu ft of aggregate

d. 6 gallons

e. 105 cu yd of sand

f. 12 turns

29. a. 30:1

b. 25 ft

c. 24 ft

d. 48:1

e. 17.3 ft

f. 22.2:1

ANSWERS TO TEST

g. 10.7 ft (10 ft 8 in)

h. 9 ft

i. 40:1

30. Evaluated to the satisfaction of the instructor

BASIC HAND TOOLS
UNIT IV

UNIT OBJECTIVE

After completing this unit, the student should be able to identify the basic hand and power tools used in highway maintenance and to operate specific tools safely and effectively. This knowledge will be shown by completing assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. State the purpose of tools.
2. Match terms associated with basic hand tools to their correct definitions.
3. Match basic tools for in-shop maintenance to their correct uses.
4. Match basic tools for field maintenance to their correct uses.
5. Match power tools to their correct uses.
6. Select from a list general rules for using tools.
7. State rules for safe use of specific hand tools.
8. Select from a list safety rules for power tools.
9. Select from a list safety rules for power saws.
10. Select from a list procedures for care and cleaning of power saws.
11. Match safety rules for operating a bench or pedestal grinder to their correct terms.
12. Select from a list procedures for sharpening tools.
13. Match safety rules for operating a drill press to their correct terms.
14. Arrange in order procedures for operating a drill press.
15. Select from a list procedures for care and cleaning of a drill press.
16. State safety rules for operating a chain saw.
17. State procedures for operating a chain saw.
18. Arrange in order procedures for felling a tree with a chain saw.
19. Match procedures for cutting felled logs to their correct operations.

OBJECTIVE SHEET

20. Complete hand tool safety test.
21. Complete power tool safety test.
22. Complete power saw safety test.
23. Complete grinder safety test.
24. Complete drill press safety test.
25. Complete chain saw safety test.
26. Demonstrate the ability to
    a. Drawfile a flat surface.
    b. Use a hand hacksaw.
    c. Replace a hammer handle.
    d. Dig a hole with a hand shovel.
    e. Spread sand or asphaltic material with a shovel.
    f. Dig a hole with a hand posthole digger.
    g. Cut flat metal with a cold chisel.
    h. Dress a grinding wheel.
    i. Reshape a cold chisel.
    j. Reshape a screwdriver.
    k. Grind a drill bit.
    l. Drill holes with a drill press.
    m. Operate a chain saw.
    n. Fell a tree.
    o. Sharpen and adjust a chain saw blade.

BASIC HAND TOOLS
UNIT IV

SUGGESTED ACTIVITIES

I. Suggested activities

A. Order materials to supplement unit.

1. Books and pamphlets

a. *ABC's of Hand Tools.* Illustrated booklet starring Primitive Pete who misuses hand tools. Available free from General Motors Corporation, 3044 West Grand Boulevard, Detroit, Michigan 48238.

b. *Chain Saw Safety.* Leaflet, 4 pages. Order no. 699.31-128. Available from National Safety Council, 444 North Michigan Avenue, Chicago, Illinois 60611. Phone (312) 527-4800.

2. Films

a. *ABC's of Hand Tools.* Color, 16 mm, 36 minutes, General Motors Corporation, 1946. Available from General Motors Corporation, 3044 West Grand Boulevard, Detroit, Michigan 48238, and from Idaho State University Audio Visual Services, Campus Box 8064, Pocatello, Idaho 83209. Phone (208) 236-3212.

(NOTE: This is an animated film in two parts. Part I covers the handling of such tools as hammers, screwdrivers, pliers and wrenches; Part II covers files, saws, planes, drills, and punches.)

b. *Hand Patching of Potholes.* Color, 17 minutes, Oklahoma Department of Transportation, n.d. Available from Oklahoma Department of Transportation, 200 Northeast 21st, Oklahoma City, Oklahoma 73105. Phone (405) 521-4141.

(NOTE: This film shows how to identify bad places in the highway as small and deep failures. Small and deep failures in asphalt highways are repaired. A shovel, pick, and jackhammer are used.)

c. *Power Hacksaw and Band Saw.* Color, 16 mm, 12 minutes, BFA Educational Media, Phoenix Films, 1969. Available from Phoenix Films, 468 Park Avenue South, New York, New York 10016. Phone (212) 684-5910.

(NOTE: This film, part of the Industrial Education series, demonstrates the correct techniques for cutting heavy gauge metal with the power hacksaw, the lighter gauge metal with the band saw. It emphasizes safety practices and proper maintenance of the saw and blades, and discusses various kinds of blades available and their safe installation.)

SUGGESTED ACTIVITIES

d. *Safety - For Safety's Sake.* Black and white, 16 mm, 20 minutes, University of Kansas, n.d. Available from University of Kansas, Audio-Visual Center, 746 Massachusetts Street, Lawrence, Kansas 66044. Phone (913) 864-3352.

(NOTE: This film demonstrates how to use, inspect, and care for portable power tools. Actual on-the-job scenes illustrate various operating hazards and give specific instructions for handling drills, grinders, saws, and electrical tools safely.)

e. *Safety in the Shop: Hand Tools.* Color, 16 mm, 12 minutes, Coronet Division of Esquire, Inc., 1970. Available from Coronet Division of Esquire, Inc., 65 East South Water Street, Chicago, Illinois 60601; or from Oklahoma State University, Audio-Visual Center, 216 Library, Stillwater, Oklahoma 74078. Phone (405) 624-7216.

(NOTE: This film shows the advantage in both wood and metal shops of keeping hand tools in good condition, the need to keep saws and chisels sharp, and possible dangers from broken handles, worn tips, and burrs. It emphasizes the importance of protective clothing, and demonstrates safe use of forge and welding equipment.)

f. *Safety in the Shop: Power Tools.* Color, 16 mm, 14 minutes, Coronet Division of Esquire, Inc., 1970. Available from Coronet Division of Esquire, Inc., 65 East South Water Street, Chicago, Illinois 60601; or from Oklahoma State University, Audio-Visual Center, 216 Library, Stillwater, Oklahoma 74078. Phone (405) 624-7216.

(NOTE: This film stresses common sense safety practices in using woodworking and metal working machines, including drill press, grinder, jointer, router, saws, and lathes. It shows the need for proper clothing, machine guards, making adjustments before starting a machine, dealing with broken blades, and neatness.)

B. Make transparencies.

C. Provide students with objective sheet.

D. Provide students with information, assignment, and job sheets.

E. Discuss unit and specific objectives.

F. Discuss information and assignment sheets.

G. Demonstrate and discuss procedures outlined in job sheets.

H. Provide alternate jobs if those in job sheets are not practical.

SUGGESTED ACTIVITIES

I. Bring basic hand tools into class to demonstrate and discuss operation and allow students to handle tools.

J. Arrange field trip to a maintenance shop so that students can see power tools, shop arrangement, safety hazards, and accident prevention techniques.

K. Provide information on various tools not included in the Information Sheet.

L. Give test.

II. Instructional materials

A. Objective sheet

B. Suggested activities

C. Information sheet

D. Transparency masters

1. TM #1--Major Parts of the Horizontal Band Saw
2. TM #2--Horizontal Saw Operations
3. TM #3--Parts of the Drill Press

E. Assignment sheets

1. Assignment Sheet #1--Complete Hand Tool Safety Test
2. Assignment Sheet #2--Complete Power Tool Safety Test
3. Assignment Sheet #3--Complete Power Saw Safety Test
4. Assignment Sheet #4--Complete Grinder Safety Test
5. Assignment Sheet #5--Complete Drill Press Safety Test
6. Assignment Sheet #6--Complete Chain Saw Safety Test

F. Answers to assignment sheets

G. Job sheets

1. Job Sheet #1--Drawfile a Flat Surface
2. Job Sheet #2--Use a Hand Hacksaw
3. Job Sheet #3--Replace a Hammer Handle
4. Job Sheet #4--Dig a Hole with a Hand Shovel

SUGGESTED ACTIVITIES

5. Job Sheet #5--Spread Sand or Asphaltic Material with a Shovel
6. Job Sheet #6--Dig a Hole with a Hand Posthole Digger
7. Job Sheet #7--Cut Flat Metal with a Cold Chisel
8. Job Sheet #8--Dress a Grinding Wheel
9. Job Sheet #9--Reshape a Cold Chisel
10. Job Sheet #10--Reshape a Screwdriver
11. Job Sheet #11--Grind a Drill Bit
12. Job Sheet #12--Drill Holes with a Drill Press
13. Job Sheet #13--Operate a Chain Saw
14. Job Sheet #14--Fell a Tree
15. Job Sheet #15--Sharpen and Adjust a Chain Saw Blade

H. Test

I. Answers to test

III. Unit references

A. Brown & Sharpe Catalog #STM80. *The Shop Tool Manual.* North Kingston, Rhode Island: Brown & Sharpe Manufacturing Company, 1980.

B. Kibbe, Richard R., et al. *Machine Tool Practices.* New York: John Wiley and Sons, 1979.

C. McCarthy, Willard J., and Robert E. Smith. *Machine Tool Technology.* Bloomington, Illinois: McKnight and McKnight, 1968.

D. *Tools and Their Uses.* Washington, D.C.: Bureau of Naval Personnel NAVPERS 10085-B, 1971.

BASIC HAND TOOLS
UNIT IV

INFORMATION SHEET

I. Purpose of tools--To allow the operator to perform a variety of maintenance procedures quickly, safely, and effectively

II. Terms and definitions

A. Abrasive--Cutting surface or agent on a grinding wheel

B. Buck--To cut a log into pieces or lengths

C. Burr--Sharp edge left on a metal part from filing or sharpening

(NOTE: Deburr means to remove burrs and smooth the edge.)

D. Chips--Small bits of materials thrown from cutting, drilling, or sawing

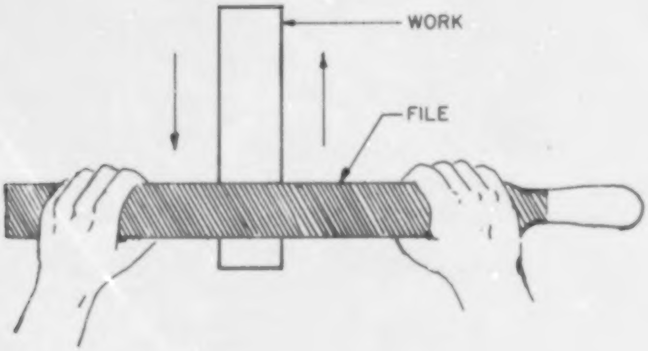
E. Circumference--Distance around a round object

F. Diameter--Distance across a round object

G. Drawfiling--Pushing and pulling a file sideways along the work (Figure 1)

EXAMPLE:

FIGURE 1



H. Dressing--Making new, sharp cutting agents on the face of the grinding wheel by removing worn surface

I. Face of grinding wheel--Outside circumference

J. Fell--To cut down a tree

K. Grit--Size of abrasive-- 515

(NOTE: Size ranges from 23 to 500. The higher the number, the larger the grit.)

INFORMATION SHEET

L. Honing--Removing the wire edge with a fine abrasive stone after a tool has been ground

M. Kerf--Amount of material consumed each time a saw makes a cut

N. Kickback--Action of tool jumping up or jerking backwards

O. Tang--The pointed end of a file

P. Trueing--Cutting the grinding wheel circumference to make all points the same distance from the center

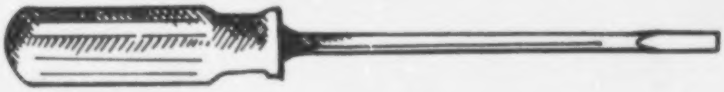
III. Basic tools for in-shop maintenance (Figures 2-22)

(NOTE: Some in-shop tools will also be used in field maintenance operations.)

A. Standard screwdriver--Used to tighten or loosen screws and bolts which have a slotted head (Job Sheet #10)

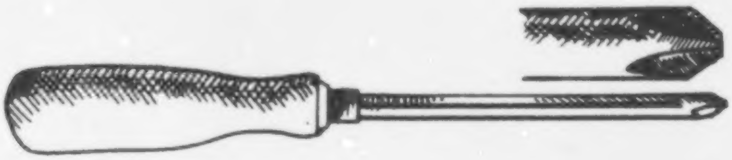
(NOTE: Screwdrivers are made in many sizes. Select the size that fits the screw head.)

FIGURE 2



B. Phillips screwdriver--Used to tighten or loosen screws and bolts which have a head with four slots that slant downward

FIGURE 3

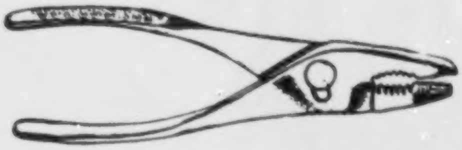


INFORMATION SHEET

C. Standard pliers (slipjoint pliers)--Used for holding and gripping small articles in situations where it may be inconvenient or impossible to use hands

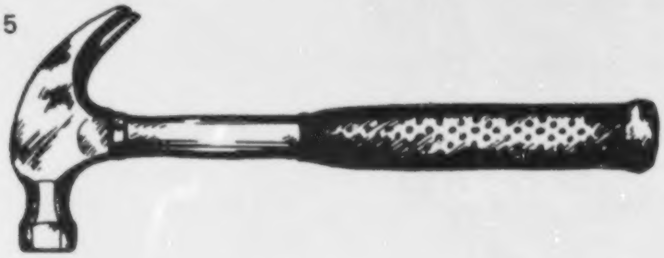
(NOTE: There are many kinds of pliers, some of which are used for cutting as well as holding and gripping. Pliers must *not* be used in place of wrenches, as they can damage a nut.)

FIGURE 4



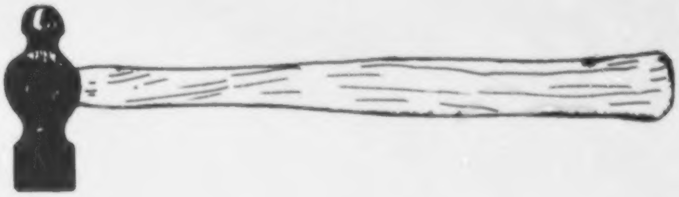
D. Claw hammer--Used to drive and remove nails

FIGURE 5



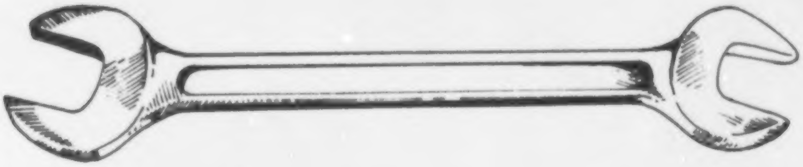
E. Ball peen hammer--Used to drive a chisel or broaden (flair) the head of a rivet or pin

FIGURE 6



F. Open-end wrench--Used to tighten or loosen square or hexagonal head bolts or nuts of a particular size

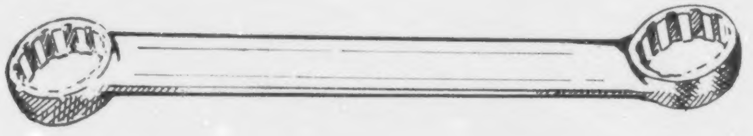
FIGURE 7



INFORMATION SHEET

G. Box wrench--Used to tighten or loosen hexagonal head bolts or nuts of a particular size; prevents slippage

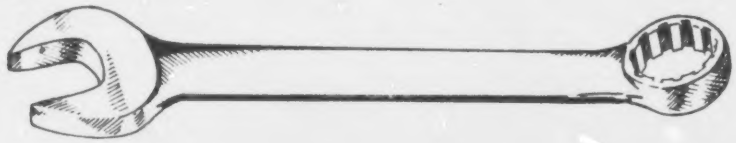
FIGURE 8



H. Combination wrench (open- and box-end)--Used to tighten or loosen square or hexagonal head bolts or nuts of a particular size; prevents slippage

(NOTE: Both ends will fit the same size nut or bolt head.)

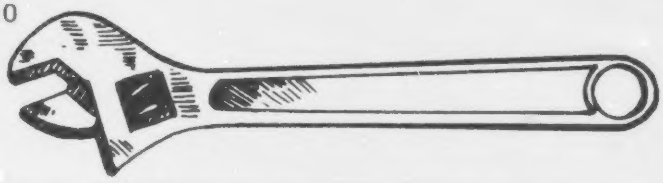
FIGURE 9



I. Adjustable wrench (crescent wrench)--Used to tighten or loosen nuts or bolts; fits many sizes

(NOTE: Be careful with an adjustable wrench. It is easy to overtighten the wrench, and it can slip and damage the nut head or bolt, or injure the user.)

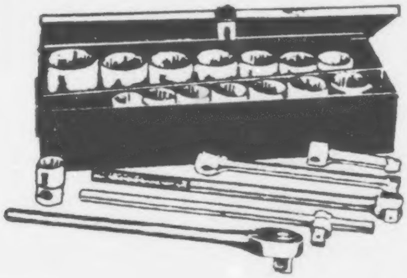
FIGURE 10



J. Socket set (ratchet)--Used to tighten or loosen bolts and nuts with hexagonal heads, usually in places where space is limited

(NOTE: The ratchet permits movement without removing the socket from the bolt. This is useful when working on equipment.)

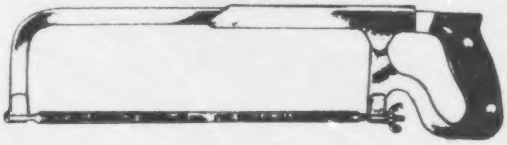
FIGURE 11



INFORMATION SHEET

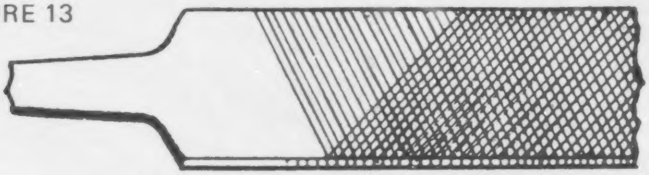
K. Hacksaw--Used to saw metal parts (especially pipe) to size or shape by hand

FIGURE 12



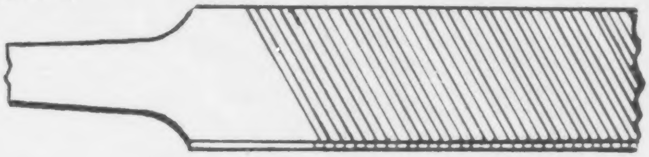
L. Double-cut file--Used to shape metal, to remove large amounts of material quickly

FIGURE 13



M. Single-cut file--Used to finish a sharp edge; gives a smooth finish

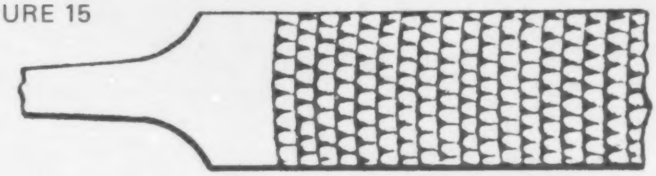
FIGURE 14



N. Rasp file--Used to file soft metals quickly

(NOTE: Files come in various shapes and lengths, and have several kinds of teeth.)

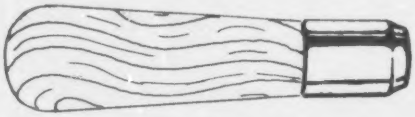
FIGURE 15



O. File handle--Used to cover the tang of a file

(NOTE: A file handle makes the file safe to use and gives the user a convenient surface to hold when filing. Without a file handle, it is likely that the tang will be driven into the user's hand.)

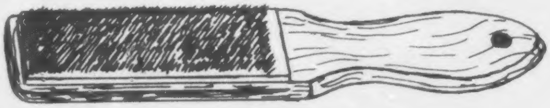
FIGURE 16



P. File card--Used to clean a file

(NOTE: Some file cards have short wire bristles on one side for cleaning hard, embedded particles from a file, and a brush on the other side to finish cleaning.)

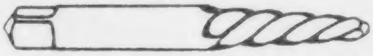
FIGURE 17



Q. Screw extractor ("easy out")--Used to remove bolts and screws whose heads have been broken off or damaged

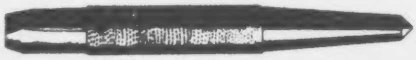
(NOTE: A screw extractor is turned with another tool such as a tap handle, T-handle, or socket wrench.)

FIGURE 18



R. Punch--Used to mark the location of a hole before drilling by making a dent in the surface of the material (Job Sheet #12)

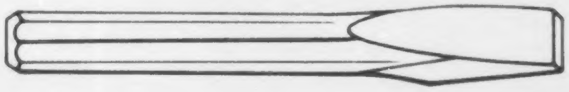
FIGURE 19



INFORMATION SHEET

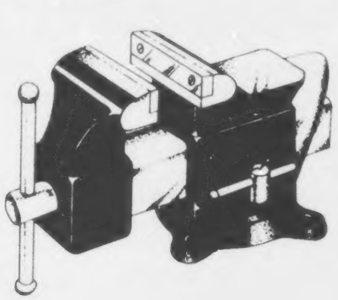
S. Cold chisel--Used for chipping flat surfaces and for cutting rivet heads and thin sheet metal (Job Sheets #7 and #9)

FIGURE 20



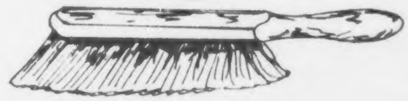
T. Bench vise--Used to hold parts for sawing, filing, and other hand operations (Job Sheets #1, #2, and #3)

FIGURE 21



U. Counter or bench brush--Used when cleaning up work area; has long, fine bristles that will clean up fine chips

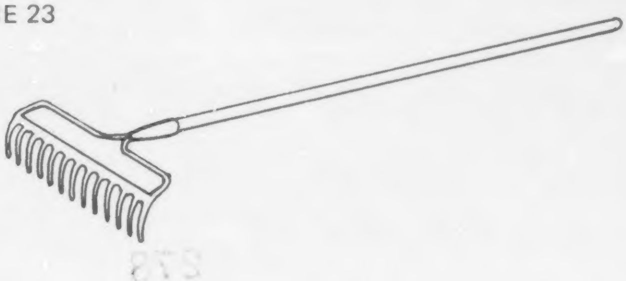
FIGURE 22



IV. Basic tools for field maintenance (Figures 23-43; Job Sheets #4-#6)

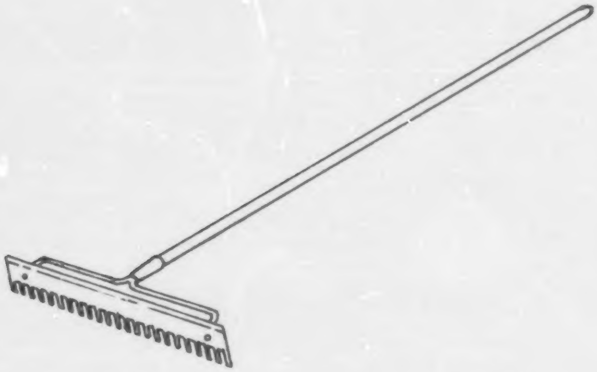
A. Garden rake--Used for raking weeds and grass

FIGURE 23



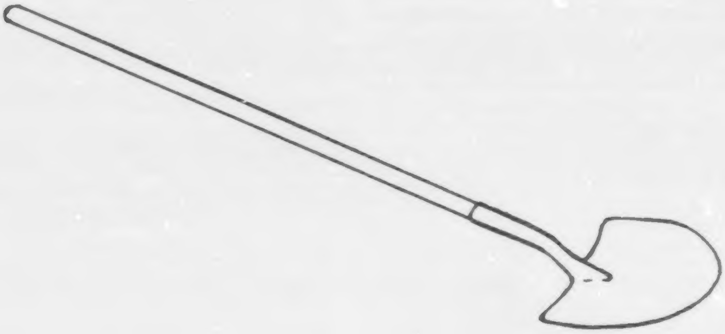
B. Asphalt rake--Used for feathering asphalt to a smooth finish, patching large overlays, and placing cold asphalt mix

FIGURE 24



C. Round-point shovel--Used for handling gravel and rocky fill, digging holes, and spreading material

FIGURE 25

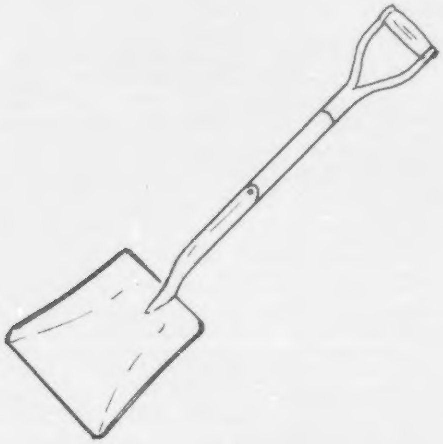


INFORMATION SHEET

D. Square-point shovel--Used for smoothing, handling sand, cleaning ditches, spreading materials, and leveling

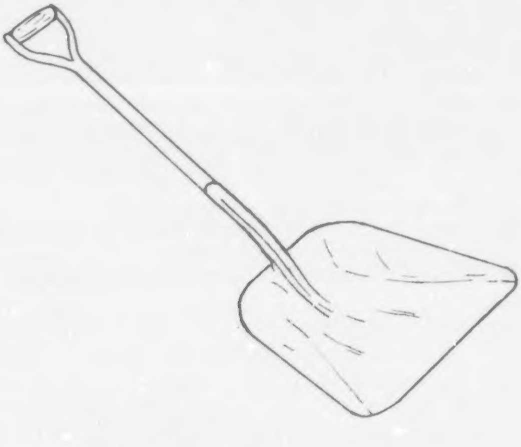
(NOTE: The use of a long-handled or short-handled shovel is generally a matter of personal preference. However, short-handled shovels are better for handling heavier materials.)

FIGURE 26



E. Scoop shovel--Used for shop cleanup, asphalt patching cleanup, and spreading chips or sand

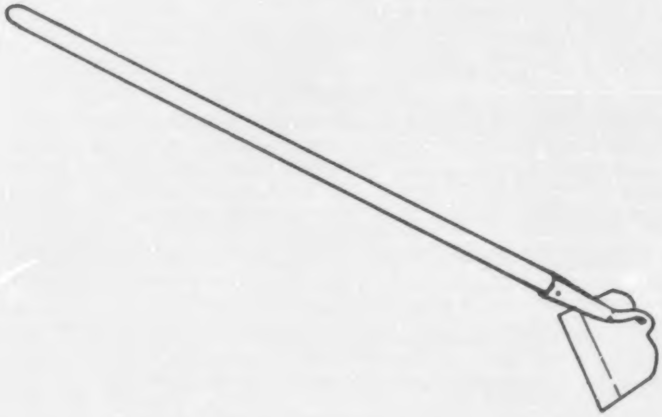
FIGURE 27



INFORMATION SHEET

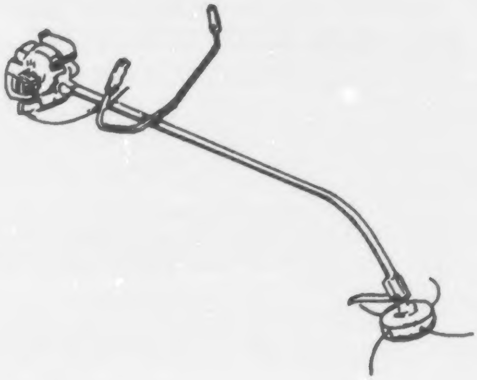
F. Hoe--Used for cutting weeds and mixing concrete

FIGURE 28



G. Weed cutter--Used to cut grass or weeds, particularly around guardrails, bridge abutments, and culverts

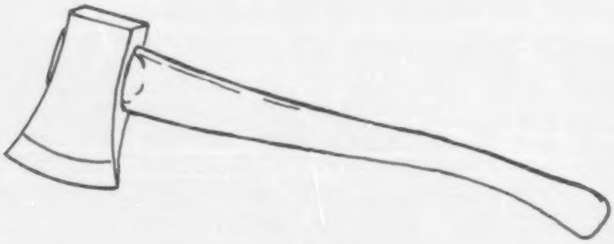
FIGURE 29



INFORMATION SHEET

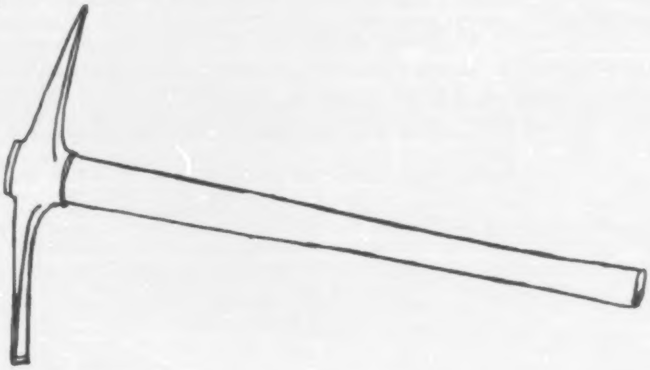
H. Ax--Used for chopping brush, and cutting limbs and trees

FIGURE 30



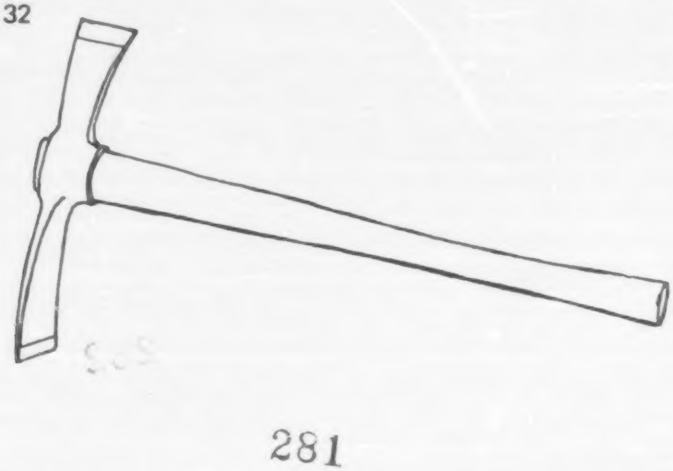
I. Pick--Used to trim sides of holes for patching asphalt, breaking off edges of asphalt, and loosening rocks

FIGURE 31



J. Mattock--Used for clearing small brush, digging, chopping, digging in asphalt, and squaring up holes

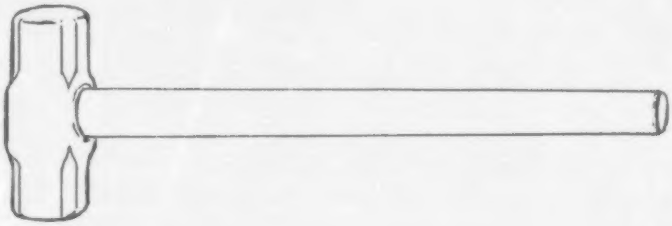
FIGURE 32



INFORMATION SHEET

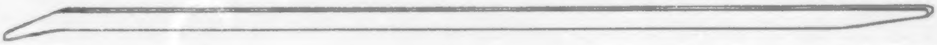
K. Sledgehammer--Used for driving small signposts, breaking rocks, and driving stakes

FIGURE 33



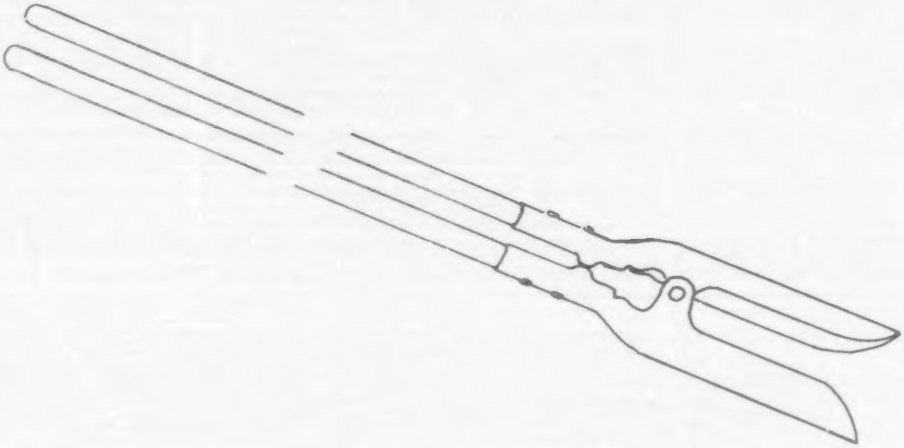
L. Pry bar (or pointed bar)--Used to dislodge rocks, loosen dirt, and lift equipment or rocks

FIGURE 34



M. Hand posthole digger--Used to dig postholes

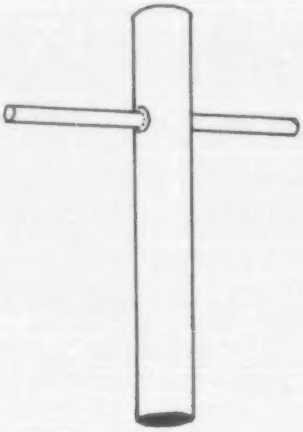
FIGURE 35



INFORMATION SHEET

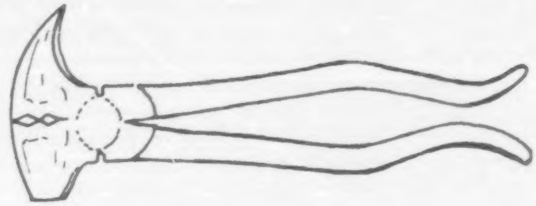
N. Fence-post driver--Used to drive delineator posts or steel fence posts into the ground

FIGURE 36



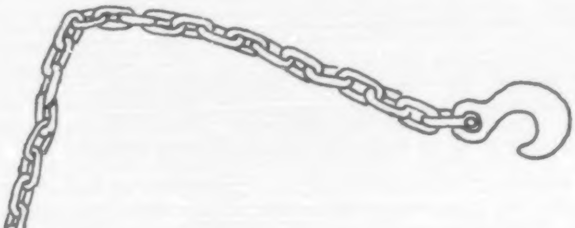
O. Fencing pliers--Used to repair fences, cut wire, and stretch barbed wire

FIGURE 37



P. Log chain--Used for towing

FIGURE 38

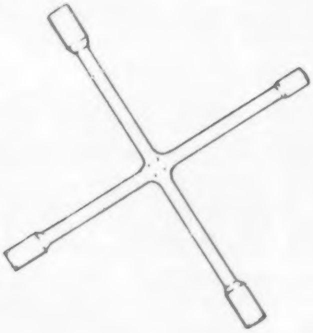


INFORMATION SHEET

Q. Tire changing tools

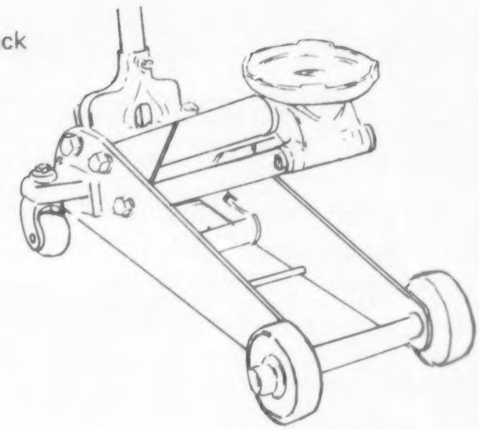
1. Lug wrench

FIGURE 39



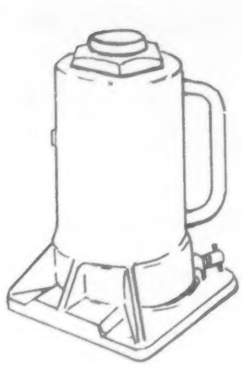
2. Floor jack

FIGURE 40



3. Hydraulic jack

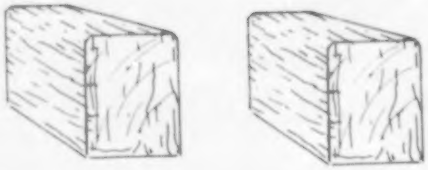
FIGURE 41



INFORMATION SHEET

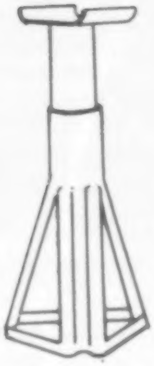
4. Blocks

FIGURE 42



5. Jack stand

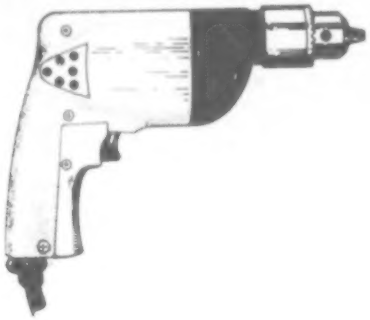
FIGURE 43



V. Power tools (Figures 44-48; Assignment Sheets #2-#6; Job Sheets #8-#15)

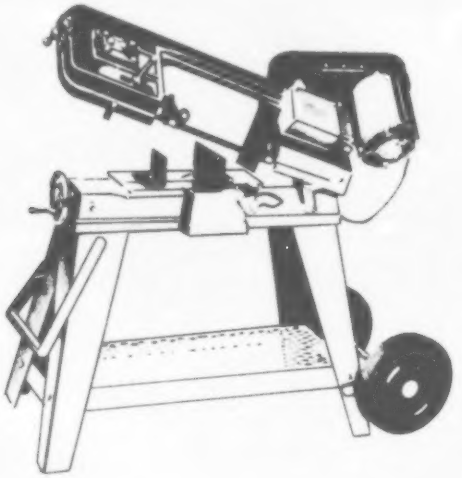
A. Electric drill--Used for drilling holes, particularly in signposts (Job Sheet #11)

FIGURE 44



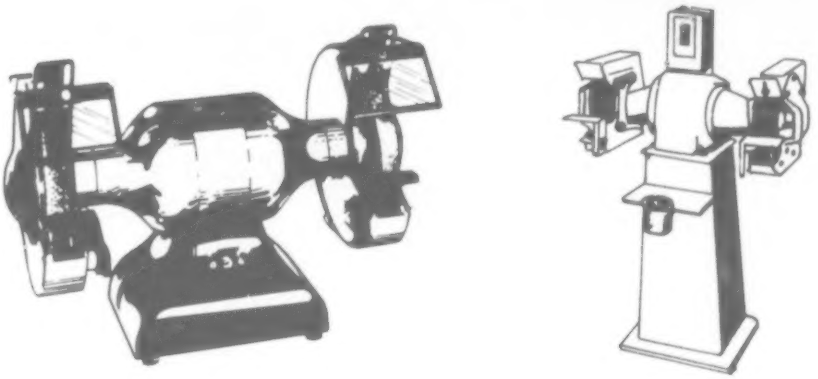
B. Band saw--Used for cutting posts and cutting out signs (Transparencies #1 and #2; Assignment Sheets #2 and #3)

FIGURE 45



C. Grinder (bench or pedestal)--Used for sharpening blades, grinding and shaping tools, and cleaning metal parts (Assignment Sheet #4; Job Sheets #8-#11)

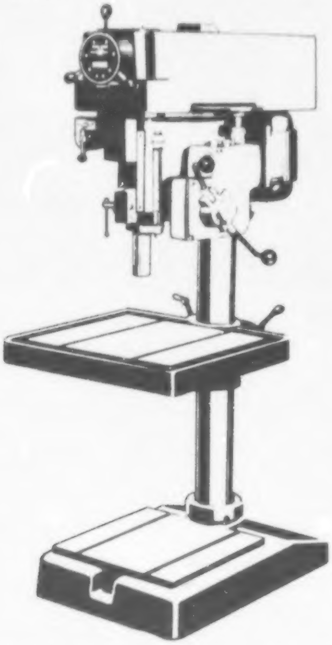
FIGURE 46



INFORMATION SHEET

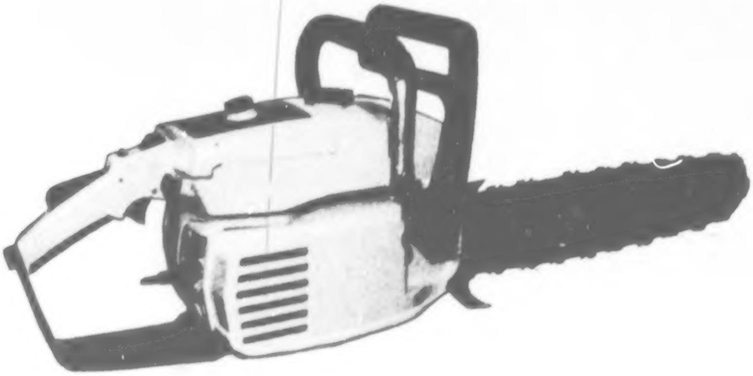
D. Drill press--Used to produce round holes in material by using twist drills and other types of cutting tools (Transparency #3; Assignment Sheet #5; Job Sheets #11 and #12)

FIGURE 47



E. Chain saw--Used for clearing brush, cutting signposts, cutting timbers for wood bridges, and cutting guardrail posts (Assignment Sheet #5; Job Sheets #13-#15)

FIGURE 48



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INFORMATION SHEET

VI. General rules for using tools

- A. Always use a tool to do work for which it was designed
- B. Keep all tools clean; wipe chips and grease off before storing
- C. Inspect tools frequently to make sure they are in good working condition
- D. Wear safety goggles when required
- E. Protect tools from rust; oil after using
- F. Always store tools properly

  EXAMPLES:
  1. Cutting edges should be protected.
  2. Tools should not be placed where they can roll off benches or tables.
  3. Storage area should be free of moisture to prevent corrosion.
  4. Heavier tools should be placed where they will not be tripped over.
- G. Keep cutting edges sharp
- H. Repair broken or damaged tools promptly
- I. Dispose of broken tools that cannot be repaired
- J. Stay alert any time you use hand tools or power tools
- K. Store sharp or pointed tools in a place where you will not stab yourself with them

VII. Rules for safe use of specific hand tools (Assignment Sheet #1)

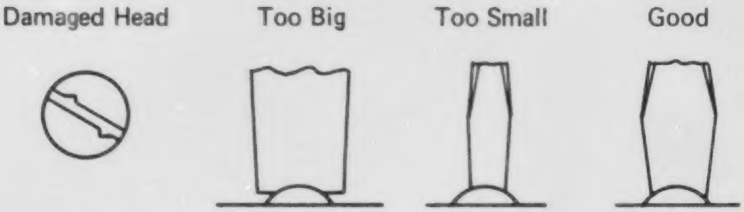
- A. Screwdrivers
  1. Never use a screwdriver as a chisel because such use will damage the screwdriver
  2. Never hold work while using a screwdriver; lay it on a bench or hold it in a vise; if the screwdriver slips, it can cause a stab wound

INFORMATION SHEET

3. Always use a screwdriver that fits the head of the screw, or you will damage the screw or screwdriver (Figure 49)

EXAMPLES:

FIGURE 49

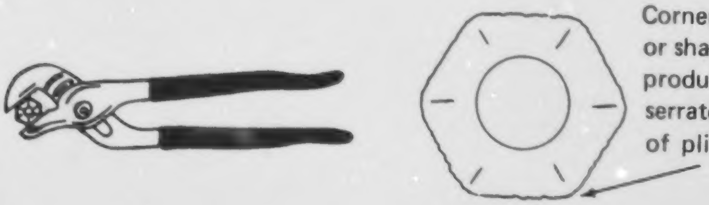


B. Pliers

1. Do not use pliers to loosen or tighten a bolt or nut; they will damage the head
2. Never use pliers to grip finished surfaces because the teeth will score the work (Figure 50)

EXAMPLE:

FIGURE 50



Corners rounded or sharp edges produced with serrated edge of pliers

3. If you must use pliers on a bolt or nut, use locking pliers that will not slip as easily

C. Hammers

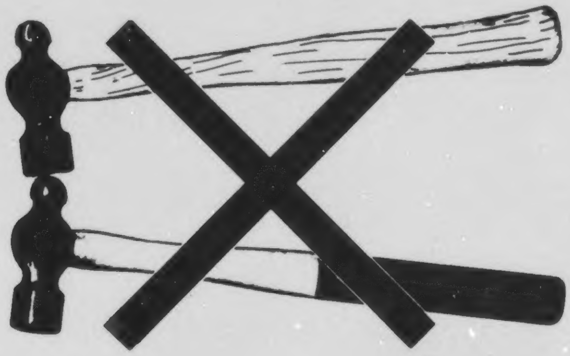
1. Never use a hammer that has a split handle or loose head; the head may break off, causing injury or damage
2. Never use a hammer on precision parts

INFORMATION SHEET

3. Never strike two hard surfaces together; a piece may break off one of them and hurt someone or damage the parts (Figure 51)

EXAMPLE:

FIGURE 51

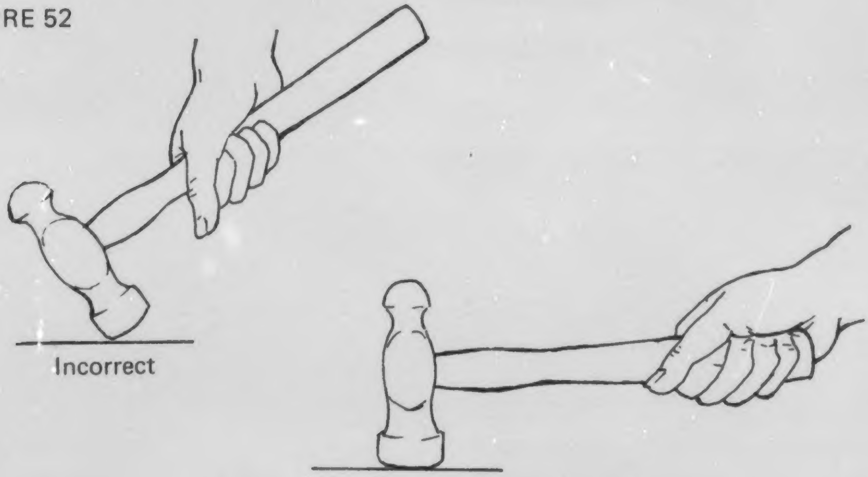


4. Hold the handle close to the end to increase the lever arm and produce a more effective blow

5. Hold the hammer at such an angle that the face of the hammer and the surface of the object being hit will be parallel (Figure 52)

EXAMPLE:

FIGURE 52



Incorrect

Correct

INFORMATION SHEET

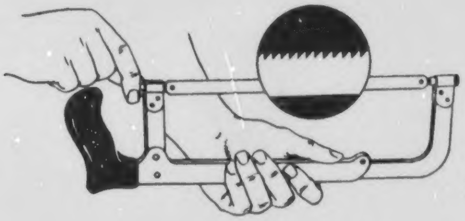
D. Wrenches

1. Select the correct size and type of wrench for each job
2. Do not extend wrench handle with pipe or other device
3. Do not use an open wrench to free a "frozen" nut or to do the final tightening of a hex nut
4. Pull on the wrench--do not push
5. Tighten in a clockwise direction-- ↻
6. Loosen in a counterclockwise direction-- ↺

E. Hacksaw

1. Place material in vise grip close to vise jaws
2. Use correct blade for material being cut
3. Blade teeth should point forward (Figure 53)

FIGURE 53



4. Blade should be rigid and tight
5. Wear safety glasses
6. Use less pressure just before blade cuts through material so that your hands will not strike vise or material
7. Use strong, steady strokes directed away from yourself
8. Use the entire length of the blade in the stroke
9. Cut thin, flat pieces across the surface so that several teeth are cutting at all times

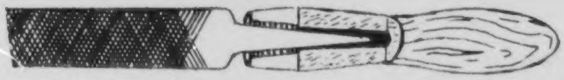
   (NOTE: Do not cut thin, flat pieces from edge to edge.)

INFORMATION SHEET

F. Files

1. To prevent possible stab wounds from the spearlike point (tang), never use a file without a handle (Figure 54)

FIGURE 54



2. Never use a file as a pry bar; it will break and can cause injury

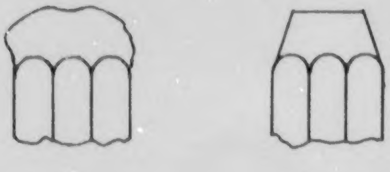
3. When filing, apply pressure on *forward* stroke only

G. Chisels

1. Never use a chisel with a mushroomed head, as the head can chip off and cause injury; grind the head smooth (Figure 55)

   EXAMPLE:

FIGURE 55



Mushroomed Head

Smooth Head

2. When using a chisel for chipping, always chip *away* from yourself and others

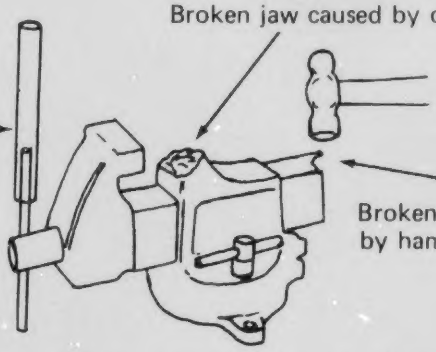
INFORMATION SHEET

H. Bench vise

1. Always clamp work well in the jaws
2. Do not use a cheater bar or hammer to tighten vise
3. Never hammer on vise guides; the casting will not stand the force (Figure 56)

EXAMPLE:

FIGURE 56


Broken jaw caused by overtightening
Cheater Bar
Broken cast guide caused by hammering

I. Shovels

1. Handles should be free of splinters, cracks, and splits
2. Blade should be sharp and free of jagged and split edges

J. Picks, mattocks, axes

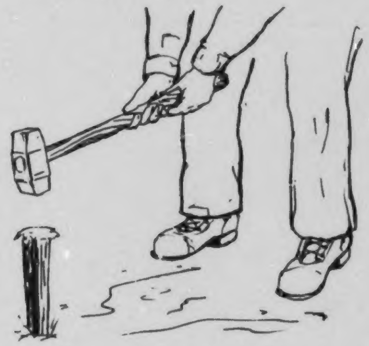
1. Handles should be free of splinters, splits, and cracks
2. Head should be firmly affixed to handle
3. Areas in back and to sides of work area must be clear when swinging
4. These tools should not be used to strike metal or to drive other tools

INFORMATION SHEET

K. Sledgehammer

1. Avoid rebound toward other workers; head will bounce after the strike
2. Handle should be free of splinters, splits, and cracks
3. Object being driven should be between the swing of the tool and your feet and legs (Figure 57)

FIGURE 57



4. Be sure you have enough room for the swing
5. The sledgehammer should not be used to strike a hammer, another sledgehammer, or a maul

L. Posthole digger

1. Blade should be sharp and free of jagged and split edges
2. Keep toes turned out away from the blades
3. Grip should be such that you do not bang your knuckles together

M. Jacks

1. Select jacks heavy enough to raise and hold load
2. Place jack on firm, level foundation, adequate to support load
3. Place jack in line with vertical movement of load

   (NOTE: Place jack under the frame, not under the bumper.)

4. Securely block load before removing jack
5. Lubricate frequently

INFORMATION SHEET

VIII. Safety rules for power tools (Assignment Sheet #2)

A. Do not use any tool until you understand how to operate it

B. Check machine and make all adjustments *before* turning on the power

C. Make sure other persons are clear of tool before turning on the power

D. Be sure that all guards are in place and functioning properly

E. Start and stop your own machine, and stay with it until it stops completely

F. Do not leave a running machine unattended

G. Disconnect electrical power before oiling, cleaning, or adjusting

H. Do not look away or talk to others while operating a power tool

I. Check power line frequently for breaks in the insulation

(NOTE: When electric tools are used in wet areas, the operator is exposed to a shock hazard. All insulation should be sound and clean.)

J. Wear gloves, safety shoes, safety glasses, and ear protection when needed

K. Remove watches, rings, or other jewelry which could get caught in moving parts

L. Keep work areas clean

M. Repair or replace worn or damaged parts immediately

N. Operate gasoline-engine-driven tools only in well-ventilated areas

O. Stop gasoline-engine-driven tools before refueling

P. Do not smoke when refueling or checking fuel

IX. Safety rules for power saws (Assignment Sheet #3)

A. Never operate saw without covers and guards in place

B. Never touch or place hands close to moving saw blades

C. Wear goggles to protect eyes from chips

D. Do not wear gloves while operating saw

E. Operate machine controls yourself

F. Never force or bind saw blade

G. Keep floor area clean and scraps picked up

INFORMATION SHEET

H. Always use a wooden block to push piece through when cutting small parts

I. Report broken parts or improper operation to your instructor or proper authority

J. Shut off power switches before adjusting any part on machine

K. Never drop blade on the work or shove work into blade

(NOTE: It will strip out teeth.)

L. Do not force blade when doing contour work; make sure blade will cut radius without bending

M. Handle cut parts, which have sharp edges, with care until they have been deburred

X. Procedures for care and cleaning of power saws

A. Check all grease fittings and oil levels daily

B. Replace brushes that clean chips from blade when brushes are worn

(NOTE: Chips will damage rubber on band saw wheels.)

C. Clean coolant tanks and add or replace coolant as needed

(NOTE: Service tanks every two to five weeks, depending on use.)

D. Clean chips from base and wheel guards daily

E. Check blade for set and missing teeth before using

F. Check guides and rollers frequently to make sure they are properly adjusted and working

G. Clean saw filter screen daily; more often during heavy use

XI. Safety rules for operating a bench or pedestal grinder (Assignment Sheet #4; Job Sheets #8-#11)

A. Starting--Stand to one side until grinding wheel has reached its maximum rpm

(NOTE: If the grinding wheel is going to fly apart, it will do so when first turned on.)

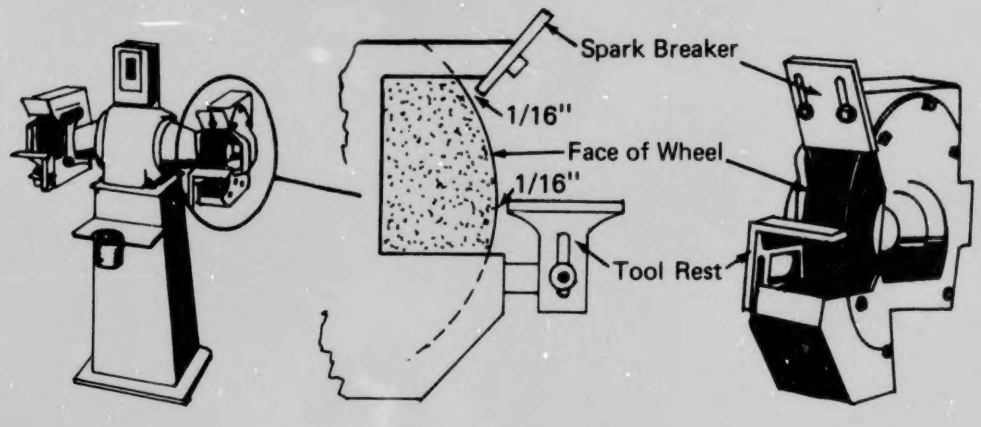
INFORMATION SHEET

B. Tool rest and spark breaker--Should be set a maximum of 1/16 inch from face of grinding wheel (Figure 58)

(NOTE: Too much clearance may cause wheel to pull work down between wheel and tool rest, jamming the wheel.)

EXAMPLE:

FIGURE 58


Spark Breaker
1/16"
Face of Wheel
1/16"
Tool Rest

C. Adjustments--Never set tool rest or spark breaker while wheel is turning

D. Gloves--Never wear these when operating the grinder

(NOTE: Most tools being ground are small; the wheel can easily grab gloves, injuring fingers.)

E. Eyes--Wear a face shield or goggles over your safety glasses (Figures 59 and 60)

EXAMPLES:

FIGURE 59

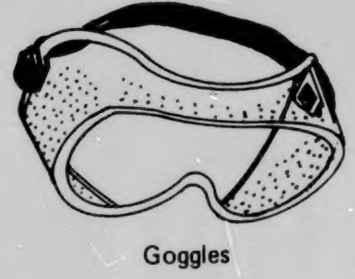
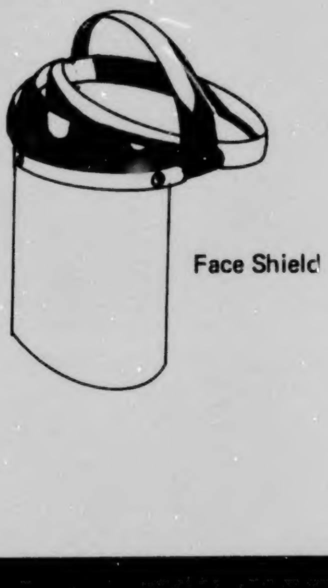


FIGURE 60

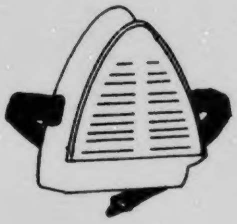

Face Shield

INFORMATION SHEET

F. Respirator--Should be worn for protection during prolonged grinder use (Figure 61)

EXAMPLE:

FIGURE 61



G. Excessive vibration--Turn off power to stop grinder; move to side of grinding wheel until wheel has stopped

(NOTE: This may be a danger signal that the wheel is loose on the spindle or out of balance due to a nick; the wheel could explode.)

H. Face of grinding wheel--Must be flat and free of grooves or rounded edges (Figures 62 and 63)

EXAMPLES:

FIGURE 62

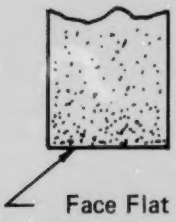
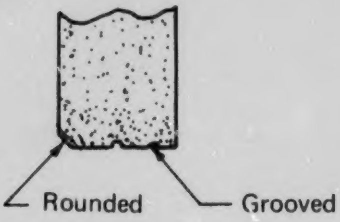


FIGURE 63



I. Pressure--Feed work into the wheel slowly and gradually; never shove it in

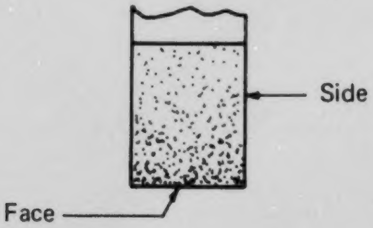
(NOTE: Too much pressure will cause excessive heat in the part. Also, if the work slips, your hand could jam into the wheel.)

INFORMATION SHEET

J. Side of wheel--Never grind here; the strength of the wheel is inward from face to center (Figure 64)

EXAMPLE:

FIGURE 64



K. Nonferrous materials (materials not containing iron)--Do not grind brass, aluminum, copper, wood, plastic, and other such materials

(NOTE: Nonferrous materials will load the pores of the wheel, causing it to be ineffective for grinding.)

L. Glazing--Sharp point of the abrasive becomes dull and requires more pressure to cut

(NOTE: This will heat the part excessively. A glazed or "loaded" wheel needs to be dressed so that new cutting edges are exposed.)

M. Electrical switches--Never try to repair; if the grinder does not work, notify instructor or proper authority

N. Burns--The tool or part you have been grinding is hot; do not touch it

(NOTE: The tool bit will heat to 400°F without changing color.)

O. Guards--Never operate a grinder with these removed

P. Horseplay--Can cause you or a friend to lose fingers or be seriously hurt

(CAUTION: Never play around machinery.)

XII. Procedures for sharpening tools (Job Sheets #8-#11)

A. Use oilstone or grindstone

(NOTE: If an abrasive wheel must be used, grind only a small amount at a time, with tool rest not more than 1/8 inch from the wheel.)

B. Hold tool *lightly* against the wheel to prevent overheating

C. Dip tool in water frequently to keep it cool

D. Wear safety goggles

INFORMATION SHEET

XIII. Safety rules for operating a drill press (Transparency #3, Assignment Sheet #5; Job Sheet #12)

A. Eyes--Always wear safety glasses to protect from chips

B. Clothing--Always wear close-fitting clothes which are less likely to get caught in revolving parts

C. Guards--Never operate the drilling machine with these removed

D. Chuck key or drill drift--Should be removed immediately after using; if left in place when machine is turned on, they will be thrown and can cause injury

E. Watches and rings--Remove before operating drill press to prevent possible accidents

F. Chips--Remove with a brush, never your hands

G. Rags--Should never be used while machine is running, and should never be left on the table of a running machine

H. Workpiece--Should always be held in a vise or other device secured to the table; never try to hold it with your hands

I. Feed pressure--Ease up when the drill is breaking through so that it will not grab and leave a big burr

J. Machine in motion--Never clean or make adjustments while machine is running

K. Hands--Never pick up a drill, work, or any tool that you have been using, as it is hot and will burn; use a rag

L. Table--Should be kept clean and free of tools to eliminate accidents and possible damage to tools

M. Drilling deep holes--Interrupt the feed occasionally to break up chips and clear the drill

N. Neatness--Keep work area and machine clean and free of slippery materials or chips to prevent accidents

O. Tools--Clean oil or coolant from drills and other tools and store them in the proper place

P. Hair--Long hair must be secured under a hat, in a hairnet, or tied back to keep it from getting caught in rotating parts

(NOTE: Short hair is preferred.)

INFORMATION SHEET

XIV. Procedures for operating a drill press (Transparency #3; Assignment Sheet #5; Job Sheet #12)

(CAUTION: A drill press can crush your hand. Use extreme caution when operating it.)

A. Use the correct drill for each operation

B. Lay out center location of each hole to be drilled

C. Center punch location of holes

D. Set part in vise and tighten

E. Apply cutting oil as needed

F. Ease up on the feed pressure as the drill breaks through the work

G. Clean the machine after each use and put all tools away

XV. Procedures for care and cleaning of a drill press (Transparency #3; Job Sheet #12)

A. Check all oil levels before using

B. Check drive belts for proper tightness

C. Never crank speed selector when spindle is not turning

D. Never shift gears when spindle is turning; shut off machine

E. Clean chips off table with a brush

F. Never use a dull tool; it causes more friction and will ruin the tool

XVI. Safety rules for operating a chain saw (Assignment Sheet #6; Job Sheets #13-#15)

(CAUTION: An accident with a chain saw can happen in a matter of seconds. Be very careful, follow safety precautions, and never hurry.)

A. Read the operator's manual thoroughly

B. Do not attempt operations beyond your ability or experience

C. Wear close-fitting and protective work clothing

EXAMPLES: Safety hat, safety goggles or glasses, hard-toed shoes, heavy-duty work gloves, good grade earplugs or sound barriers

INFORMATION SHEET

D. Start the saw on firm ground, not on your leg or knee

E. Never operate a chain saw when you are tired

F. Use a firm grip with thumbs and fingers encircling the chain saw handles

G. Be alert for kickback

EXAMPLES:
1. Striking limbs or other objects with the tip
2. Striking metal, cement, or other hard material buried under or near the wood
3. Running the engine slowly at the start of, or during the cut
4. A dull or loose chain
5. Cutting above shoulder height
6. Inattention while holding or guiding saw

H. Do not fell a tree during high or changing winds

I. Plan a safe exit from a falling tree or limbs

J. Do not cut in awkward positions

EXAMPLES: Off-balance, one-handed, at the end of your reach

K. Be sure of your footing

L. Avoid prolonged operation of the chain saw, and rest often

M. Be alert for springback when cutting a limb or trunk that is under tension

N. Use extreme caution when cutting small-sized brush and saplings

(NOTE: Slender material may catch the saw chain and be whipped toward you or pull you off balance.)

O. NEVER transport saw with the chain running

P. Do not allow any other person or animal close to a running saw or a tree being felled

XVII. Procedures for operating a chain saw (Assignment Sheet #6; Job Sheets #13, #14, and #15)

A. Read the operator's manual thoroughly

B. Hold saw firmly with both hands, with thumbs and fingers encircling saw handles

INFORMATION SHEET

C. Cut at high engine speeds only

D. Preplan a safe exit from a falling tree or limbs

E. Do not let the chain saw dig into dirt

F. Keep chain well lubricated

(NOTE: Use extra oil with abrasive wood.)

G. Test chain brake before cutting

H. Sharpen or touch up blade as needed during use

I. Check blade tension periodically

(CAUTION: Wait until blade has come to a complete stop before touching it. Never touch or try to stop a moving chain with your hand.)

XVIII. Procedures for felling a tree with a chain saw (Assignment Sheet #6; Job Sheets #13 and #15)

(NOTE: The basic procedure is this: Determine the line of fall, notch the tree in the direction of the line of fall, and cut from the back, leaving a hinge to slow the fall and keep the tree from jumping back toward you. Very small trees may be cut from the back to the front as you stand to the side. An occasional push may be necessary to start the tree falling, particularly if you cut against the natural lean of the tree. Until you learn safe felling procedures, do not work alone.)

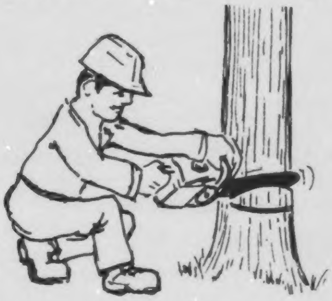
A. LOOK at tree and determine best line of fall

(NOTE: Factors which influence line of fall are direction the tree is leaning, surrounding trees which may keep tree from hitting ground, sloping ground, and wind direction.)

B. SHOUT A WARNING

C. Make a straight cut 18-24 inches off the ground on the side facing the direction of fall, 1/3 of the diameter deep (Figure 65)

FIGURE 65



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INFORMATION SHEET

D. Make a 45° angle cut 2-8 inches above the straight cut, meeting it at 1/3 the diameter of the tree

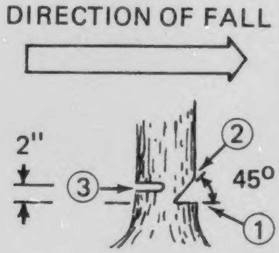
E. Make a straight cut directly behind the notch, toward the top of the angle cut (Figure 66)

(NOTE: Do not cut through to the notch. The uncut band of wood parallel to the notch serves as a hinge and keeps the tree from falling back toward you.)

(CAUTION: Always make cuts in the correct order.)

EXAMPLES:
1. Straight cut in the direction of fall
2. Angle cut
3. Straight cut from rear

FIGURE 66



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XIX. Procedures for cutting felled logs (Assignment Sheet #6; Job Sheets #13-#15)

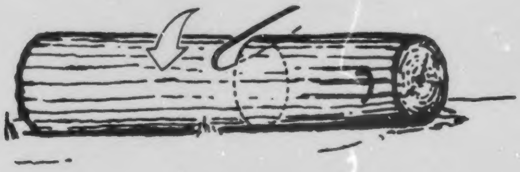
(NOTE: When bucking on a slope, always stand on the uphill side.)

A. Cutting a log supported along the entire length (Figure 67)

1. Cut from the top (overbuck)
2. Avoid cutting into the dirt

(NOTE: Roll the log away from you to complete the cut.)

FIGURE 67



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INFORMATION SHEET

B. Cutting a log supported on one end (Figure 68)

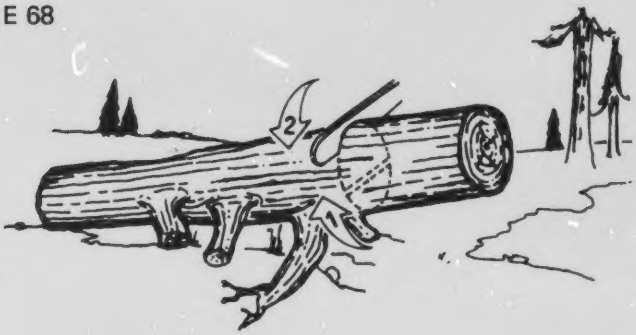
1. Cut from the bottom (underbuck) 1/3 diameter of log to avoid splitting

   (NOTE: Cutting only 1/3 the diameter keeps the log from splitting from the top.)

2. Overbuck to meet first cut and avoid pinching

   (NOTE: Overbucking the second cut keeps the saw blade from getting pinched between the two pieces.)

FIGURE 68



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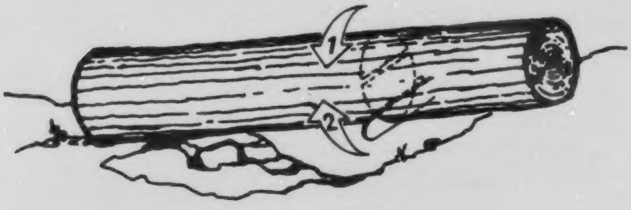
C. Cutting a log supported on both ends (Figure 69)

1. Overbuck 1/3 diameter of log to avoid splintering
2. Underbuck to meet first cut and avoid pinching

FIGURE 69



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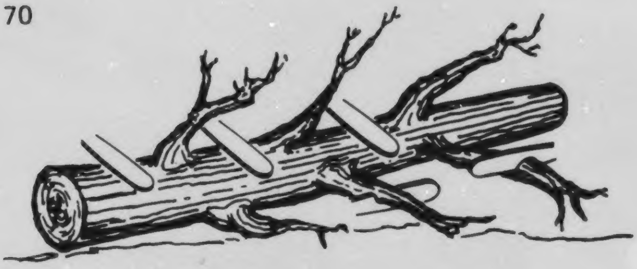
INFORMATION SHEET

D. Limbing (Figure 70)

1. Keep the log off the ground
2. Do not remove supporting limbs until after the log is bucked into lengths

FIGURE 70



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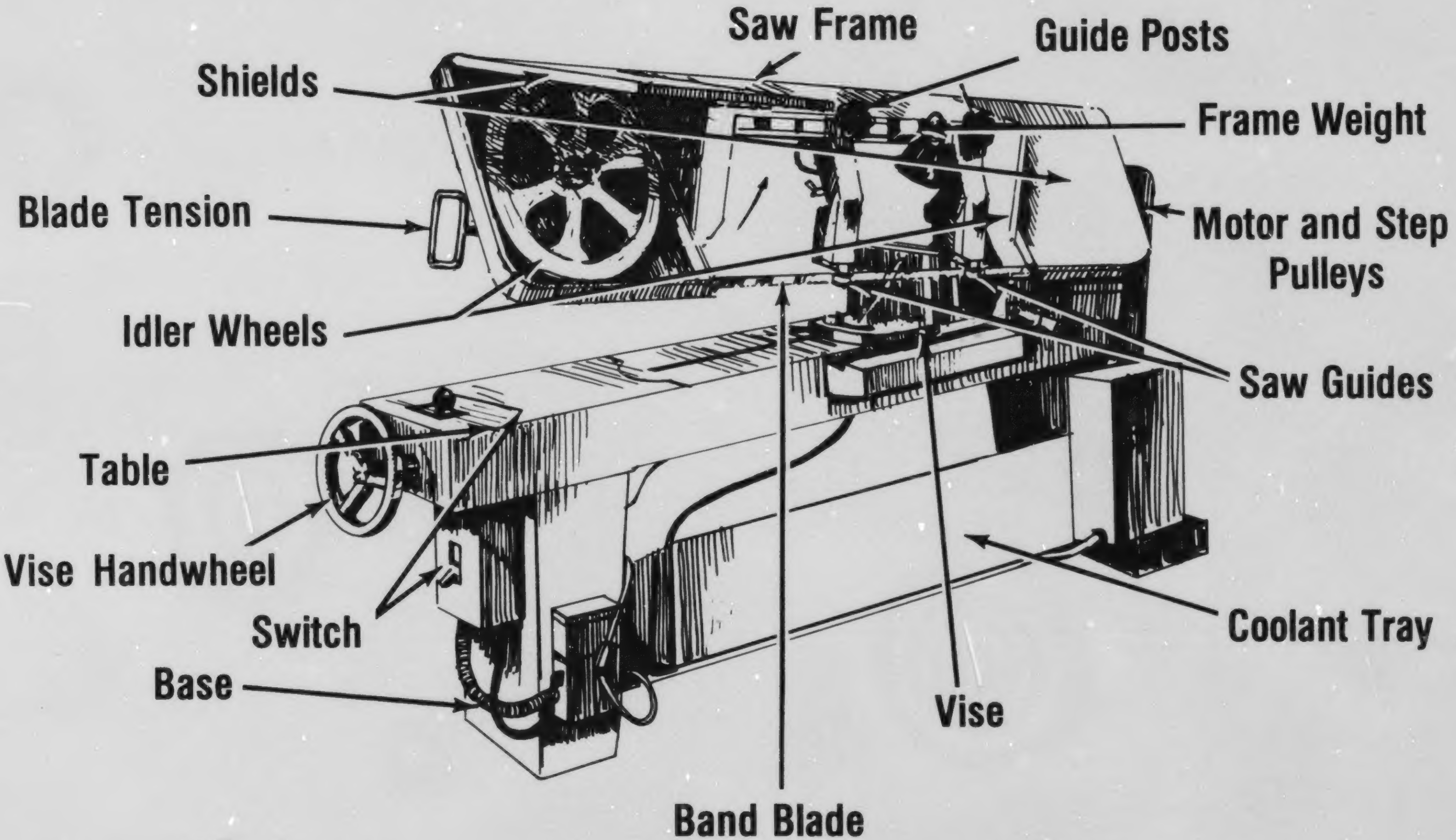
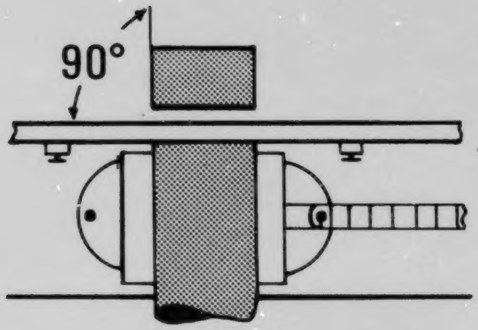
Major Parts of the Horizontal Band Saw


Saw Frame
Guide Posts
Shields
Frame Weight
Blade Tension
Motor and Step Pulleys
Idler Wheels
Saw Guides
Table
Vise Handwheel
Coolant Tray
Switch
Base
Vise
Band Blade

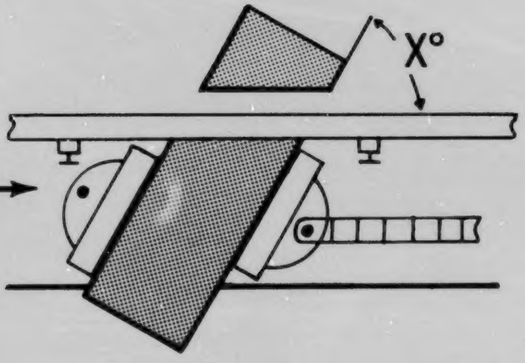
TM #1

DOT I - 319

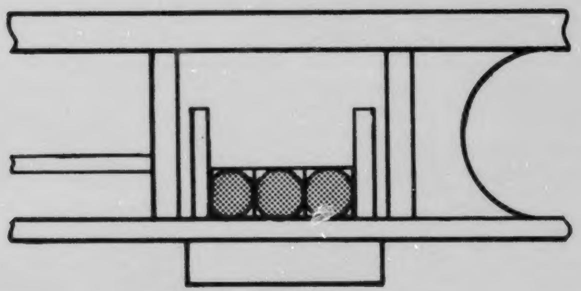
Horizontal Saw Operations



Square Cutting

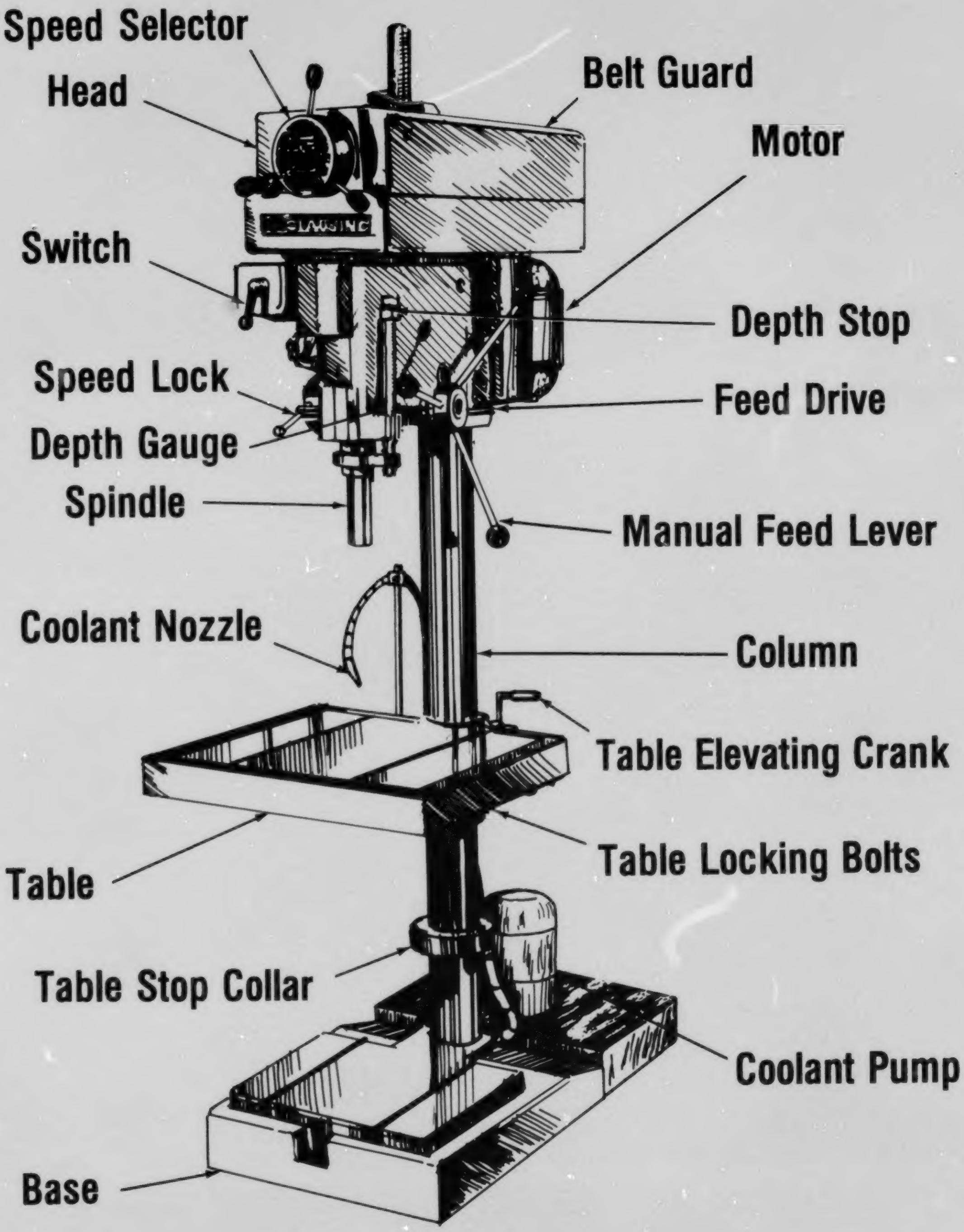


Angular Cutting



Stack Cutting

Parts of the Drill Press


Speed Selector
Head
Belt Guard
Motor
Switch
Depth Stop
Speed Lock
Feed Drive
Depth Gauge
Spindle
Manual Feed Lever
Coolant Nozzle
Column
Table Elevating Crank
Table Locking Bolts
Table
Table Stop Collar
Coolant Pump
Base
CLAUSING

BASIC HAND TOOLS
UNIT IV

ASSIGNMENT SHEET #1--COMPLETE HAND TOOL SAFETY TEST

NAME ______________________________ SCORE ______________

Safety is everyone's responsibility. You must learn how to work safely to keep from being injured. You must also learn how to use tools properly so that they do not get damaged by your misuse.

A. When using a bench vise, what three things should the user be aware of?

1. ______________________________
2. ______________________________
3. ______________________________

B. Why would it be safer to use a wrench of the correct size than an adjustable wrench?

____

____

____

C. Is it safer to pull or push a wrench? ______________________________

D. Why should you never strike two hard objects like hammers together? ______________

____

E. Why should pliers never be used to tighten or loosen nuts or bolts? ______________

____

F. Why is the tang of a file protected with a file handle? ______________________

____

G. What causes the blade of a screwdriver to chip or the head of a screw to be damaged?

____

____

H. When using a screwdriver, why is it safer to lay the work on the bench or hold it in a vise rather than holding it in your hand? ______________________________

____

ASSIGNMENT SHEET #1

I. Where should sharp and pointed tools always be stored? ______________________

____

J. Why should you never use a hammer that has a split handle or loose head? ________

____

K. What should you do to a chisel that has a mushroomed head to make it safer to use?

____

L. When chipping with a chisel, what should the user always do? ______________________

____

M. When using the hacksaw, always hold part in a vise close to jaw, and ease up on

the ______________ when you are about to cut through so that __________

will not strike the vise or material.

N. What precaution should be taken with a sledgehammer to protect other people? _____

____

O. How can you protect yourself from injury when using a hand posthole digger?

1. ____
2. ____
3. ____

P. What will reporting all accidents or damaged tools help? ______________________

____

BASIC HAND TOOLS
UNIT IV

ASSIGNMENT SHEET #2--COMPLETE POWER TOOL SAFETY TEST

NAME ______________________________ SCORE ______________

As you can see from this unit, most safety rules pertain to power tools: saws, grinder, drill press, and chain saw. While each of these tools requires specific safety precautions, there are procedures you should follow when using all power tools. The operator uses power tools in many phases of highway maintenance; and it is essential that he or she recognize the dangers and protect himself or herself, other workers, and the equipment by following sound safety rules.

Answer the following questions about safety rules for power tools.

A. What clothing should you have for protection? ______________________________

____

B. With what tools would you *not* wear gloves? ______________________________

C. What safety rules pertain to guards? ______________________________

D. Where should you operate gasoline-engine-driven tools? ______________________________

E. What safety rule applies to starting and stopping power tools? ______________________________

____

F. What safety rules involve other people?

1. ____

2. ____

G. When do you make adjustments to the machine? ______________________________

H. When are you ready to operate a power tool? ______________________________

I. Before oiling, cleaning, or adjusting power tools, what should you do? ______________

____

J. What other safety rule applies to the power line? ______________________________

____

K. What safety rules apply to refueling? ______________________________

____

L. When should you replace worn or damaged parts? ______________________________

BASIC HAND TOOLS
UNIT IV

ASSIGNMENT SHEET #3--COMPLETE POWER SAW SAFETY TEST

NAME ______________________________ SCORE ______________

Safety is of great concern to industry as well as to your learning process. Industry does not want time lost due to an accident, and time lost in training is almost impossible to make up. If you learn and apply these safety rules, you will be a safer person both on the job and in training.

Answer the following questions on safety rules for operating power saws.

A. Why should you wear safety goggles? ______________________________

____

B. Machine controls can be operated by how many people? ______________

C. What safety rules should you follow to protect the saw blade? (Name two.)

   1. ______________________________

   2. ______________________________

D. What safety rule applies when cutting small parts? ______________

____

E. What should you do about broken parts or improper operation? ______________

____

F. What safety rule should you follow before making adjustments to a power saw? ______

____

G. What is the rule regarding covers and guards? ______________

____

H. What can you do to protect your hands from injury? ______________

____

I. What safety rule applies to contour cutting? ______________

____

J. Why should you deburr cut parts? ______________

____

BASIC HAND TOOLS
UNIT IV

ASSIGNMENT SHEET #4--COMPLETE GRINDER SAFETY TEST

NAME ______________________________ SCORE ______________

The grinder is used frequently to sharpen tools and mower blades. It looks harmless but is not; safe use is possible only if proper respect is given to its possible hazards.

Answer the following questions on safety rules for operating a grinder.

A. When should you make adjustments to the tool rest or spark breaker? __________

____

____

B. What eye protection should you have? ______________________

____

____

C. Where do you position yourself when you start the grinder? __________

____

____

D. Do you wear gloves when operating a grinder? ______________

E. What is the proper set for the tool rest and spark breaker? __________

____

F. Face of grinding wheel should be in what condition? ______________

____

G. When should you wear a respirator? ______________________

____

____

H. How should you feed work into the wheel? ______________________

____

____

ASSIGNMENT SHEET #4

I. What do you do in the case of excessive vibration? ____________________

____

____

J. What do you do if the electrical switch doesn't work? ____________________

____

____

K. Why should you never grind on the side of the wheel? ____________________

____

____

L. Why is horseplay forbidden around machinery? ____________________

____

____

M. Nonferrous materials should never be ground on a grinder. What common materials are "nonferrous"? ____________________

____

____

N. What rule applies to guards? ____________________

____

____

O. What causes glazing and why is it dangerous? ____________________

____

____

P. Can you burn yourself operating a grinder? If so, tell how. ____________________

____

____

BASIC HAND TOOLS
UNIT IV

ASSIGNMENT SHEET #5--COMPLETE DRILL PRESS SAFETY TEST

NAME ______________________________ SCORE ______________

Safety and safe operation are words you will hear daily because lack of safety or safe working conditions can result in accidents and lost time due to injuries.

Answer the following questions about safety rules for operating a drill press.

A. What safety rule pertains to wearing watches and rings while operating a drill press?

B. What eye protection do you need?

C. How do you protect your hands from burns?

D. How do you remove chips safely?

E. What kind of clothing should you wear?

F. What safety rule applies to drilling deep holes?

G. What safety rule applies to handling the workpiece?

H. What safety rule applies to guards?

ASSIGNMENT SHEET #5

I. Why should the table be kept clean and free of tools?____________________

____

J. What rule pertains to feed pressure?____________________________

____

K. What will happen if you leave the chuck key or drill drift in place when you turn the machine on?____

____

____

____

L. What is the correct way to treat drills and other tools after you use them?________

____

____

M. How does neatness protect you and your tools?______________________

____

____

N. When do you *not* clean or make adjustments to the drill press?______________

____

____

O. What safety rule applies to rags in the work area?______________________

____

____

P. What precautions do you take if you have long hair?____________________

____

____

BASIC HAND TOOLS
UNIT IV

ASSIGNMENT SHEET #6--COMPLETE CHAIN SAW SAFETY TEST

NAME ______________________________ SCORE ______________

Chain saw operation can be dangerous if safety procedures are not followed. A serious cut or injury can result from failure to observe these procedures, from a moment's inattention, or from circumstances beyond the operator's control. It is essential that the operator keep alert for danger and make safety second nature when working with a chain saw.

Answer the following questions about chain saw safety rules.

A. What protective clothing should you wear to operate a chain saw? ______________

____

B. Why should you use extra caution in the following situations?

1. Cutting limbs or trunks that are under tension-- ______________

   ____

2. Cutting small-sized brush and saplings-- ______________

   ____

C. What conditions can cause kickback?

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____

D. What precautions apply to the way you handle your body around a chain saw?

1. ____
2. ____
3. ____
4. ____
5. ____

BASIC HAND TOOLS
UNIT IV

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A. 1. Always clamp work well in the jaws

  2. Do not use a cheater bar or hammer to tighten vise

  3. Never hammer on vise guides; the casting will not stand the force

B. Adjustable wrenches can slip, causing damage to the bolt or nut, or injury to the user

C. Pull

D. A piece may break off one of them and hurt someone or damage the parts

E. They will damage the head, and can cause injury if they slip

F. To prevent possible stab wound to the user

G. A screwdriver that does not fit the screw

H. If the screwdriver slips, it can cause a stab wound

I. Store sharp or pointed tools in a place where you will not stab yourself with them

J. The head can break off, causing injury or damage

K. Grind the head smooth

L. Chip *away* from self and others

M. Pressure, your hands

N. Avoid rebound toward other workers; head will bounce after the strike

O. 1. Blade should be sharp and free of jagged and split edges

  2. Keep toes turned out away from the blades

  3. Grip should be such that you do not bang your knuckles together

P. Keep all tools in good working condition and keep someone from being injured by using a damaged tool

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #2

A. Gloves, safety shoes, safety glasses, and ear protection

B. Saws, grinder

C. Guards must be in place and function properly

D. In well-ventilated areas

E. Start and stop your own machine, and stay with it until it stops completely

F. 1. Make sure other persons are clear of tool before turning on the power

   2. Do not look away or talk to others while operating a power tool

G. When power is off

H. When you understand how to operate it

I. Disconnect electrical power

J. Check frequently for breaks in the insulation

K. 1. Stop gasoline-engine-driven tools before refueling

   2. Do not smoke when refueling or checking fuel

L. Immediately

Assignment Sheet #3

A. To protect eyes from chips

B. Only one person

C. Answer may include any two of the following

   1. Never force or bind saw blade

   2. Never drop blade on the work or shove work into the blade

   3. Do not force blade when doing contour work; make sure blade will cut radius without bending

D. Always use a wooden block to push piece through

E. Report them to your instructor or proper authority

F. Shut off power switches before adjusting any part on the machine

ANSWERS TO ASSIGNMENT SHEETS

G. Saw should never be operated without covers and guards in place

H. Never touch or place hands close to moving saw blades

I. Do not force blade when doing contour work; make sure the blade will cut radius without bending

J. Cut parts have sharp edges, and should be handled with care until they have been deburred

Assignment Sheet #4

A. When wheel is not turning

B. Wear a face shield or goggles over your safety glasses

C. Stand to one side until grinding wheel has reached its maximum rpm

D. No

E. Should be set a maximum of 1/16 inch from face of grinding wheel

F. Must be flat and free of grooves or rounded edges

G. Should be worn for protection during prolonged grinder use

H. Feed work into the wheel slowly and gradually; never shove it in

I. Turn off power to stop grinder; move to side of grinding wheel until wheel has stopped

J. Never try to repair; if the grinder does not work, notify instructor or proper authority

K. The strength of the wheel is inward from face to center

L. Can cause you or a friend to lose fingers or be seriously hurt

M. Brass, aluminum, copper, wood, plastic, and other materials not containing iron

N. Never operate a grinder with guards removed

O. Sharp point of abrasive becomes dull and requires more pressure to cut; part can overheat and cause burns

P. Yes; by touching part when it is hot

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #5

A. Remove before operating drill press (or any machine) to prevent possible accidents

B. Always wear safety glasses to protect from chips

C. Never pick up a drill, work, or any tool that you have been using, as it is hot and will burn; use a rag

D. With a brush, never your hands

E. Always wear close-fitting clothes which are less likely to get caught in revolving parts

F. Interrupt the feed occasionally to break up chips and clear the drill

G. Should always be held in a vise or other device secured to the table; never try to hold workpiece with your hands

H. Never operate the drilling machine with guards removed

I. To eliminate accidents and possible damage to tools

J. Ease up when the drill is breaking through so that it will not grab and leave a big burr

K. They will be thrown and can cause injury

L. Clean oil or coolant from them and store them in the proper place

M. Keep work area and machine clean and free of slippery materials or chips to prevent accidents

N. While machine is running

O. Should never be used while machine is running, and should never be left on the table of a running machine

P. Long hair must be secured under a hat, in a hairnet, or tied back to keep it from getting caught in rotating parts

Assignment Sheet #6

A. Safety hat, safety goggles or glasses, hard-toed shoes, heavy-duty work gloves, good grade earplugs or sound barriers

B. 1. They could spring back and hit you

   2. They may catch the saw chain and be whipped toward you or pull you off balance

ANSWERS TO ASSIGNMENT SHEETS

C. Answer should include the following

1. Striking limbs or other objects with the tip
2. Striking metal, cement, or other hard material buried or near the wood
3. Running the engine slowly at the start of or during the cut
4. A dull or loose chain
5. Cutting above shoulder height
6. Inattention while holding or guiding saw

D. Answer should include any five of the following

1. Wear close-fitting and protective work clothing
2. Start the saw on firm ground, not on your leg or knee
3. Never operate a chain saw when you are tired
4. Use a firm grip with thumbs and fingers encircling the chain saw handles
5. Do not cut in awkward positions
6. Be sure of your footing
7. Avoid prolonged operation of the chain saw, and rest often

BASIC HAND TOOLS
UNIT IV

JOB SHEET #1--DRAWFILE A FLAT SURFACE

I. Tools and equipment

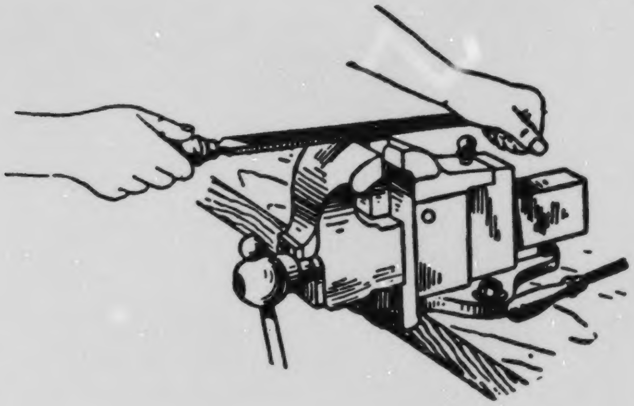
- A. File handle
- B. File
- C. Vise
- D. Piece of metal

  EXAMPLES: Chisel, ax, mower blade, hoe, shovel, scrap metal

II. Procedure

- A. Secure metal in vise
- B. Equip file with a tight-fitting handle
- C. Draw the file crosswise over the work with a light pressure (Figure 71)

FIGURE 71



- D. Apply enough pressure to keep file cutting in both directions

BASIC HAND TOOLS
UNIT IV

JOB SHEET #2--USE A HAND HACKSAW

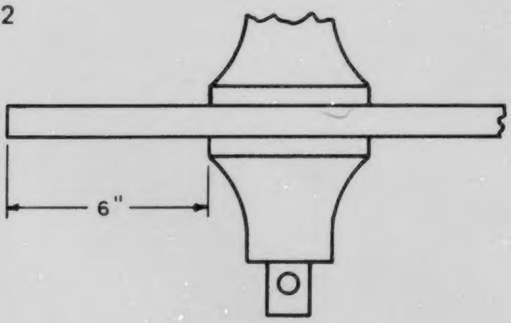
I. Tools and equipment

- A. Steel rule (scale)
- B. Soapstone
- C. Bench vise with soft jaws
- D. Hand hacksaw
- E. Thin-wall pipe or equivalent, 2'' diameter, 12' long

II. Procedure

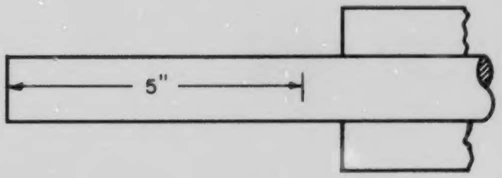
A. Clamp 2-inch thin-wall pipe in bench vise so that about 6 inches extend past edge of vise (Figure 72)

FIGURE 72



B. Use steel rule (scale) and mark a 5-inch length with soapstone (Figure 73)

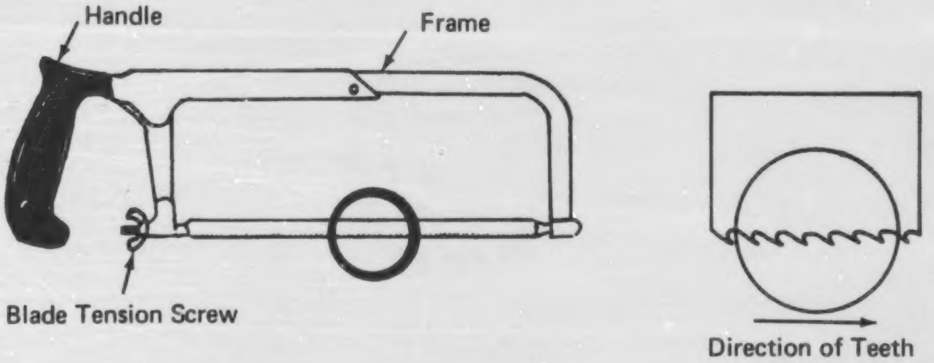
FIGURE 73



JOB SHEET #2

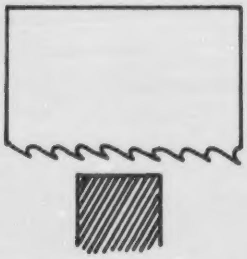
C. Check hand hacksaw to make sure that blade is tight, and that teeth are sharp and going in the right direction (Figure 74)

FIGURE 74



(NOTE: For most general purpose work, use a blade that has 12 teeth per inch; however, a fine-tooth blade should be used to cut thin metal. Keep in mind the three-tooth rule--at least three teeth in contact with work--when selecting saw blades. See Figure 75.)

FIGURE 75



D. Put the saw blade on the soapstone mark

E. Hold the saw firmly by the handle and front of the frame

F. Start a forward and back movement, applying pressure on the forward stroke; lift the saw slightly on the return strokes

(NOTE: Cut on forward movement only, and use the entire length of blade.)

G. Cut at about 40 strokes per minute

(CAUTION: When the saw is about to cut through the stock, ease up on the pressure. Otherwise you may push your hand into the sharp edge of the pipe still held in the vise.)

JOB SHEET #2

H. Deburr cut end of both pieces of pipe

I. Put away tools and leftover pipe; clean up work area

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BASIC HAND TOOLS
UNIT IV

JOB SHEET #3--REPLACE A HAMMER HANDLE

I. Tools and equipment

- A. Hammer with a broken handle
- B. Hacksaw
- C. Twist drill
- D. Punch
- E. Rasp
- F. Handsaw
- G. Mallet
- H. Vise

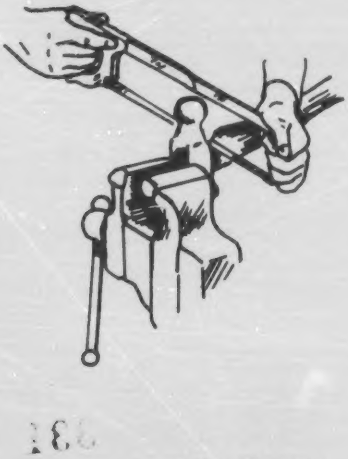
  (NOTE: Cover the jaws of the vise with sheet metal or wood blocks to prevent damage to the hammer and handle.)

- I. New handle
- J. Metal or wood wedge
- K. Safety glasses

II. Procedure

- A. Put on safety glasses
- B. Place the hammer head in the vise
- C. Saw the broken handle close to the hammer head with a hacksaw (Figure 76)

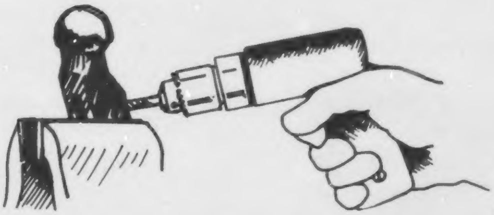
FIGURE 76



JOB SHEET #3

D. Remove the wood from the eye by first drilling with a twist drill and then punching out the remainder (Figure 77)

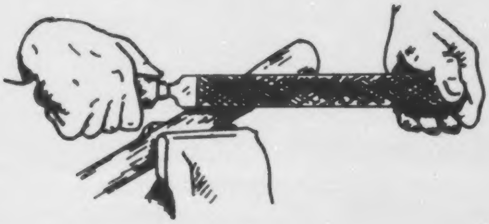
FIGURE 77



E. Place the new handle in the vise

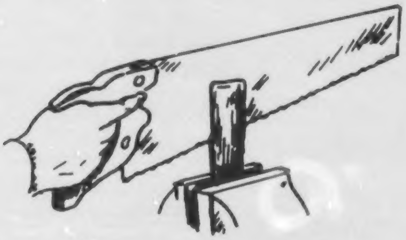
F. Work the new handle down to size with a rasp; try the handle in the head frequently (Figure 78)

FIGURE 78



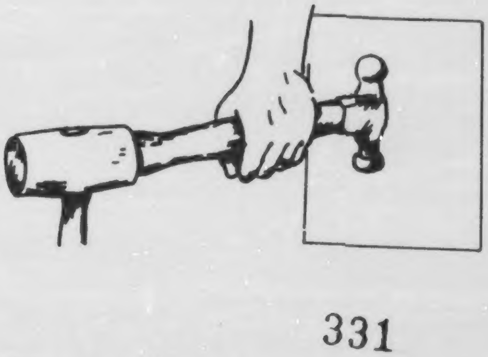
G. Using a handsaw, make a cut across the long diameter of the handle top to a distance of about 2/3 the depth of the eye (Figure 79)

FIGURE 79



H. Drive the handle firmly into place, using a mallet (Figure 80)

FIGURE 80



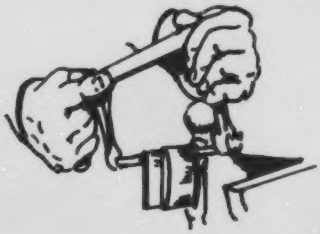
JOB SHEET #3

I. Drive wedge tightly into cut at the top of handle

J. Place hammer in the vise and use a hacksaw to cut off handle and wedge extending through the head (Figure 81)

(NOTE: If steel wedges are used, cut off excess handle, then drive the wedge.)

FIGURE 81



BASIC HAND TOOLS
UNIT IV

JOB SHEET #4--DIG A HOLE WITH A HAND SHOVEL

I. Tools and equipment

   A. Round-point shovel

   B. Square-point shovel

   C. Gloves

   D. Tape measure

   E. Hammer, 32 oz

   F. Stakes, unmarked

   G. Stakes marked with depth of cut

   H. String line

II. Procedure

   A. Determine location and extent of digging to be done

   B. Lay out work with stakes and string line

   (NOTE: Reference stakes with depth of cut marked on them should be placed 12 inches outside the digging area.)

   C. Check shovel and handle for broken or weak points

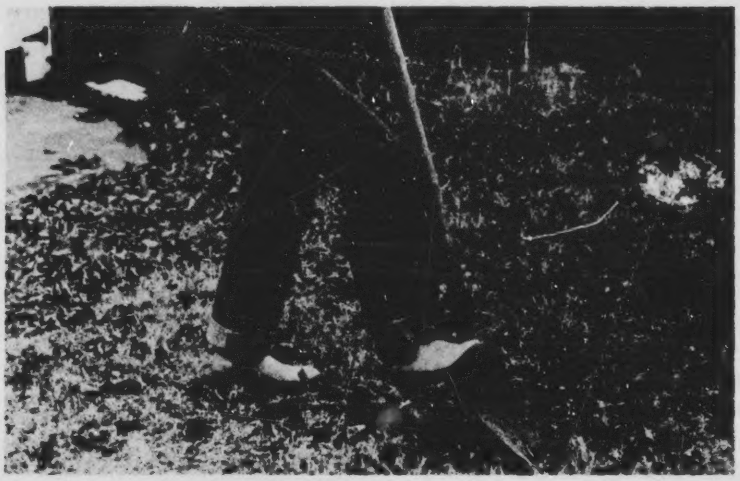
   D. Put on gloves

   E. Using a round-point shovel, start digging at the outside of the hole

JOB SHEET #4

F. Place the shovel at approximately an 80° angle to the ground (Figure 82)

FIGURE 82



G. Press shovel into the soil with the right or left foot

(NOTE: If the soil is too compact, loosen it with a pick or wet it.)

H. Lift the loaded shovel up, making sure you do not strain yourself

(CAUTION: To avoid injury or rapid exhaustion, do not take too big a bite with the shovel.)

I. Deposit the soil far enough from the digging area that it will not fall back into hole

J. Continue until desired width, length, and depth have been reached

K. Use the square-point shovel to even out, smooth, and shape the hole

L. Remove soil, mud, or other foreign matter from the shovel by scraping or washing with water or both

M. Store the shovels in a dry, safe place

BASIC HAND TOOLS
UNIT IV

JOB SHEET #5--SPREAD SAND OR ASPHALTIC MATERIAL WITH A SHOVEL

I. Tools and equipment

A. Square-point shovel

B. Gloves

C. Insulated shoes

D. Sand and/or asphaltic material

E. Diesel fuel

II. Procedure

(CAUTION: When spreading hot asphaltic material, wear protective gloves and shoes.)

A. Take a position between the material supply and the spread area

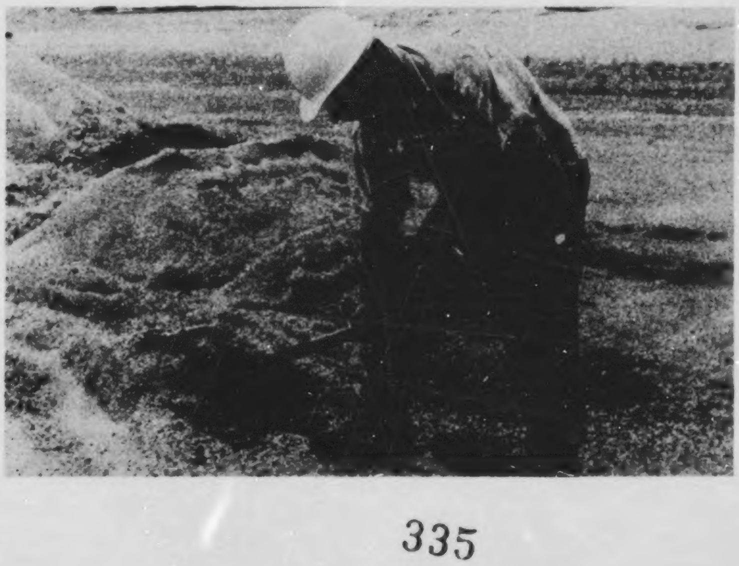
B. Grasp the shovel handle with both hands, one hand forward on the handle

C. Step toward the material supply with the same foot forward as the forward hand on the shovel handle (Figure 83)

EXAMPLE: If the right hand is forward, step toward the material supply with the right foot.

(NOTE: This procedure helps prevent sprains and wrenched or dislocated joints.)

FIGURE 83



D. Scoop up a shovelful of material; using the foot nearest the material supply as a pivot, swing around, placing the other foot near the spread area

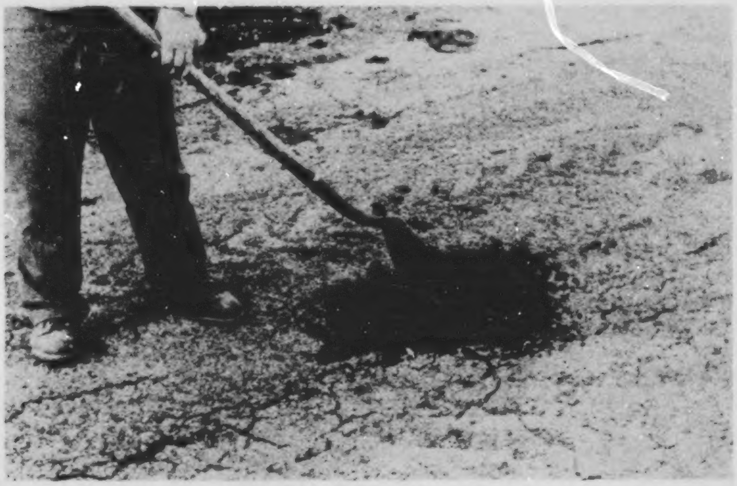
(NOTE: Use an even swing from the hips, shoulders, and arms, holding the shovel about knee-to-hip high.)

E. Tilt the shovel to keep the material in front of it

(NOTE: As the swing is completed, an even spread results.)

F. Smooth the spread surface by using the shovel as a drag (Figure 84)

FIGURE 84



G. Continue loading, spreading, and smoothing until operation is complete

H. Clean all equipment used for spreading asphaltic material with diesel fuel

BASIC HAND TOOLS
UNIT IV

JOB SHEET #6--DIG A HOLE WITH A HAND POSTHOLE DIGGER

I. Tools and equipment

   A. Posthole digger

   B. Gloves

   C. Digging bar

   D. Hammer, 32 oz

   E. Stakes

   F. Small flags and/or shovel

II. Procedure

   A. Mark location of hole with a stake

   B. Check posthole digger for broken, bent, or weak parts; replace parts if necessary

   C. Put on gloves

   D. Take a comfortable stance with feet safely out of digging area

   (NOTE: If working on a slope, take a position on the high side of the hole.)

   E. Check to make sure there is adequate overhead and side clearance for lifting the digger and spreading the handles

   F. Place hands near the top end of the handles and raise your arms as high as they can comfortably go

   G. Hold handles close together and bring the digger down against the soil with enough force to drive the shells three or four inches into the ground

   (CAUTION: Keep toes turned away from digger.)

   H. Spread the handles apart at the top

   (NOTE: Shovel halves will close and trap the dirt.)

   I. Lift the digger with the handles spread apart and swing it two to three feet to the side of the hole

   J. Push handles together to spill dirt

   (NOTE: If your knuckles hit together, grasp the handles differently.)

JOB SHEET #6

K. Use digging bar if rocks become a problem; loosen rocks and lift them out

L. Continue digging to a depth of 2 1/2 feet

M. Mark the hole with flag to warn others, or fill it in with a shovel

BASIC HAND TOOLS
UNIT IV

JOB SHEET #7--CUT FLAT METAL WITH A COLD CHISEL

I. Tools and equipment

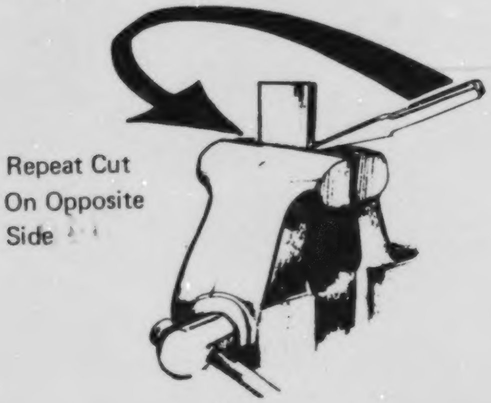
- A. Marker (oval or chalk)
- B. Flat strip of metal
- C. Chisel
- D. Hammer
- E. Vise
- F. Full face shield
- G. Ruler

II. Procedure

- A. Measure and mark the metal
- B. Place the metal in the vise with the cutting mark just above the jaws
- C. Select proper size chisel and hammer

  (NOTE: For larger size metal, use a larger chisel and hammer.)
- D. Put on face shield
- E. Place the chisel at side of the metal to start the shearing point (Figure 85)

FIGURE 85



- F. Hold the chisel at approximately a 60° angle

JOB SHEET #7

G. Make cuts from each end of the metal to the center and on both sides

(NOTE: Drive the chisel with a hammer.)

H. Bend metal back and forth until it breaks

BASIC HAND TOOLS
UNIT IV

JOB SHEET #8--DRESS A GRINDING WHEEL

I. Tools and equipment

A. Grinding wheel

B. Correct size dresser for the wheel

(NOTE: Wheel diameters of 3 to 10 inches should be dressed with a number zero [#0] dresser.)

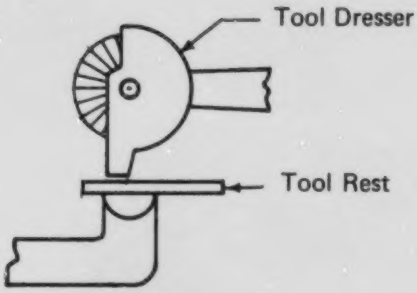
C. Face shield or goggles

II. Procedure

A. Put on face shield or goggles

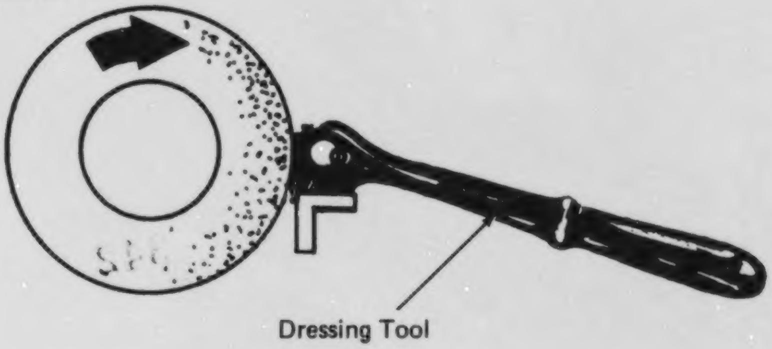
B. Set the bottom pads of the dresser on the tool rest (Figure 86)

FIGURE 86



C. Set the dressing tool on the grinder tool rest and press it firmly against the wheel (Figure 87)

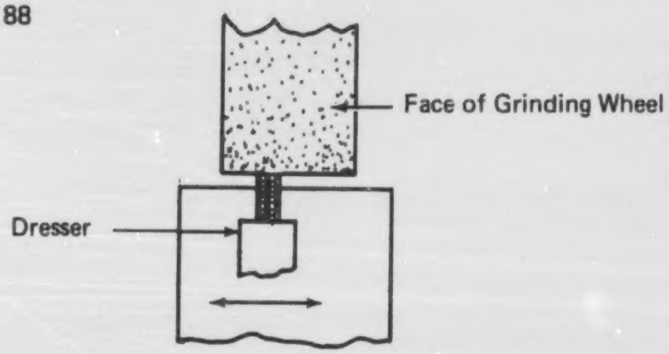
FIGURE 87



JOB SHEET #8

D. Slide the dresser into the grinding wheel until there are no sparks (Figure 88)

FIGURE 88


Face of Grinding Wheel
Dresser

E. Move dresser evenly back and forth across the face

(NOTE: Keep angle constant.)

F. Continue this procedure until the wheel has a smooth, sharp, flat face

BASIC HAND TOOLS
UNIT IV

JOB SHEET #9--RESHAPE A COLD CHISEL

I. Tools and equipment

   A. Cold chisel

   B. Grinder

   C. Container of water

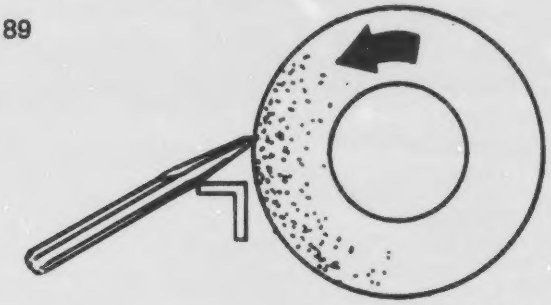
   D. Full face shield

II. Procedure

   A. Put on face shield

   B. Hold the chisel at a 65° to 70° angle with the handle pointing down (Figure 89)

FIGURE 89

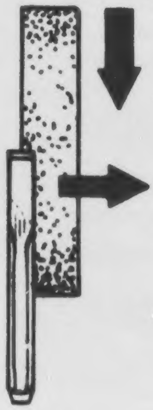


Side View

   C. Move the point from side to side across the grinding wheel (Figure 90)

   (NOTE: Dip the point in water frequently to keep it cool.)

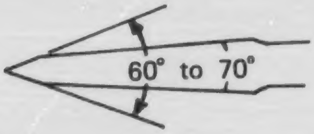
FIGURE 90



JOB SHEET #9

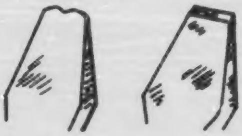
D. Grind both sides of the cutting edge in the same manner (Figure 91)

FIGURE 91



E. Grind the head back into shape if it becomes grooved (Figure 92)

FIGURE 92



BASIC HAND TOOLS
UNIT IV

JOB SHEET #10--RESHAPE A SCREWDRIVER

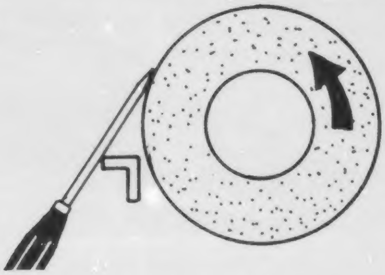
I. Tools and equipment

- A. Grinder
- B. Screwdriver
- C. Screw with head size equal to the width of the screwdriver blade
- D. Container of water
- E. Full face shield

II. Procedure

- A. Put on face shield
- B. Place screwdriver against the grinder wheel at a 90° angle to square the tip
- C. Apply light pressure on blade while grinding
- D. Change the angle and shape both faces of screwdriver evenly (Figure 93)

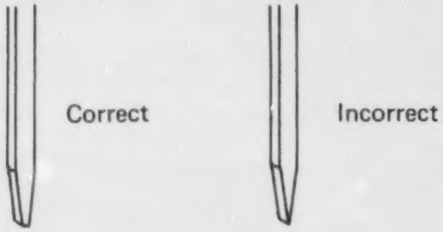
FIGURE 93



- E. Use screw head to determine the extent of grinding desired

  (NOTE: Do not round or sharpen the end. See Figure 94.)

FIGURE 94



- F. Dip point in water frequently to keep it cool

BASIC HAND TOOLS
UNIT IV

JOB SHEET #11--GRIND A DRILL BIT

I. Tools and equipment

  A. Drill point gauge

  B. Drill to sharpen (size 3/8 to 3/4 inch)

  C. Bench or pedestal grinder

  D. Face shield or goggles

  E. Grinding wheel dresser

II. Procedure

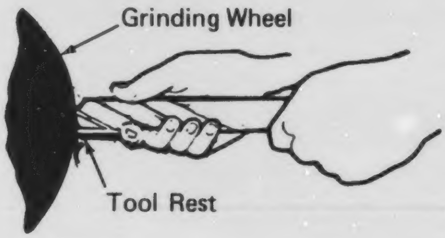
(NOTE: Grinding a drill bit correctly is difficult. You will need a lot of practice to do it well.)

  A. Put on face shield or goggles

  B. Dress the grinding wheel

  C. Hold the drill near the point with one hand, and put the other hand on the shank (Figure 95)

FIGURE 95

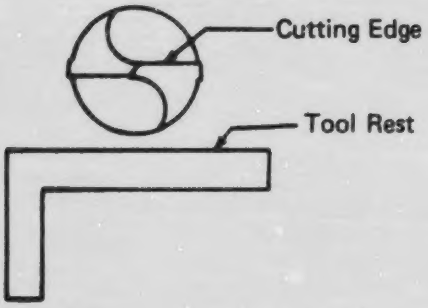


JOB SHEET #11

D. Hold the lip on cutting edge of the drill parallel to the tool rest (Figure 96)

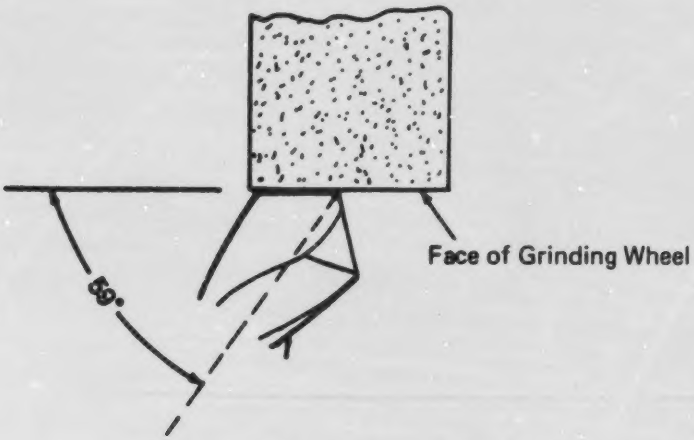
(NOTE: Be sure to place *face side* of drill bit against the grinding wheel.)

FIGURE 96


Cutting Edge
Tool Rest

E. Turn the drill until it is at approximately a 59° angle to the face of the grinding wheel (Figure 97)

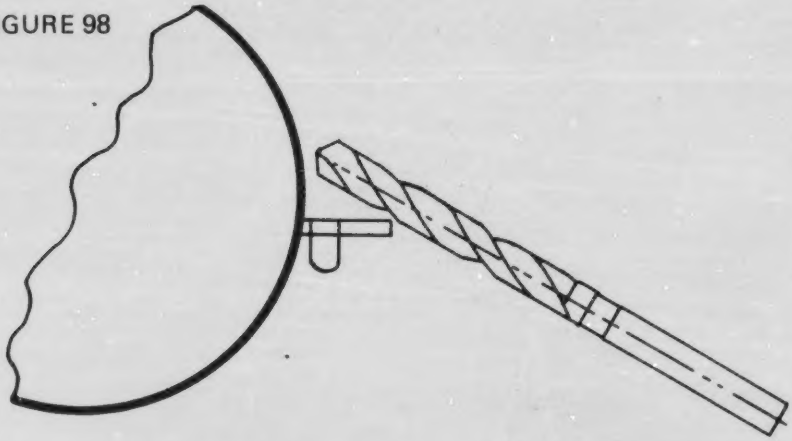
FIGURE 97


59°
Face of Grinding Wheel

JOB SHEET #11

F. Hold the drill so that the point is higher than the shank (Figure 98)

FIGURE 98



G. Bring the lip of the drill against the wheel and lower the shank

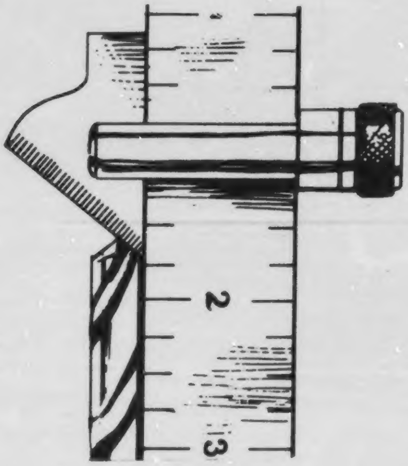
(NOTE: Do not twist the drill.)

H. Pull the drill away from the wheel and rotate the drill one-half turn

I. Grind the other lip in the same manner as above

J. Check the angle and cutting lip length by using a drill point gauge (Figure 99)

FIGURE 99



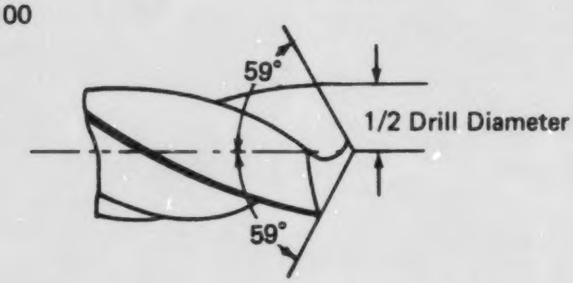
K. Repeat operations D through J until the angles are correct

JOB SHEET #11

L. When the drill is ground correctly, all these conditions will be present

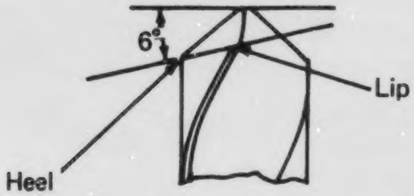
1. Drill will have a 59° angle per side or a 118° included angle (Figure 100)

FIGURE 100



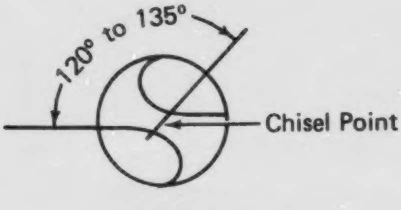
2. Drill will have a heel clearance angle of 6° to 9° (Figure 101)

FIGURE 101



3. The angle of the lip to the chisel point will be from 120° to 135° depending on the heel clearance angle (Figure 102)

FIGURE 102



M. Clean up your area, put tools in proper place, and take drill bit to your instructor for evaluation

(NOTE: If a drill bit is not ground properly, it will not drill a hole of the correct size, or it may not drill a hole at all. Soon the bit will be ruined because too much pressure will be needed to operate it.)

BASIC HAND TOOLS
UNIT IV

JOB SHEET #12--DRILL HOLES WITH A DRILL PRESS

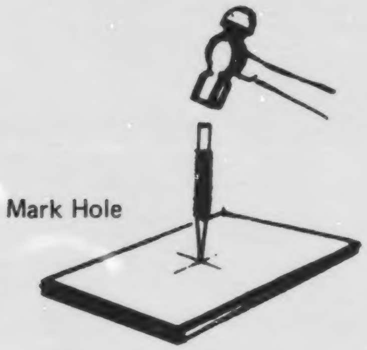
I. Tools and equipment

- A. Small piece of flat material
- B. Drill press
- C. Center punch
- D. Hammer
- E. Wooden block
- F. Cutting oil
- G. C-clamp
- H. Safety goggles

II. Procedure

- A. Mark the hole with a center punch (Figure 103)

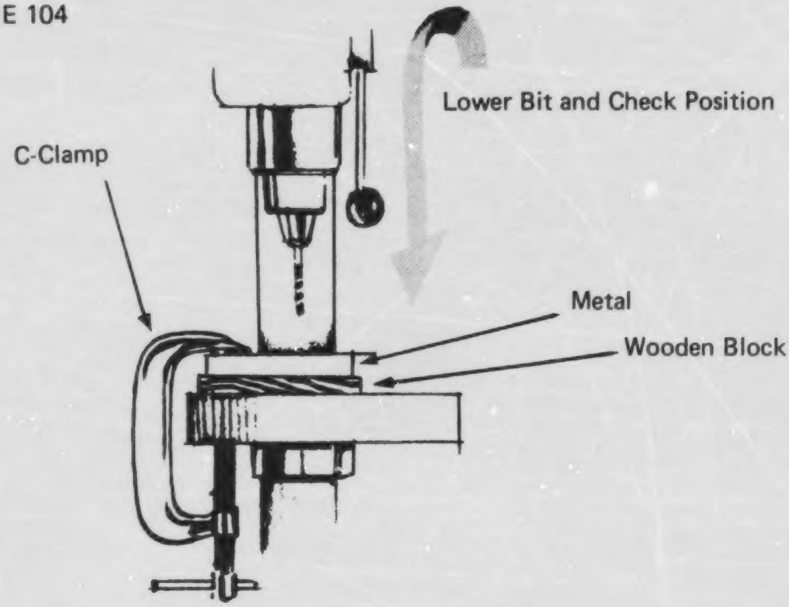
FIGURE 103



- B. Place the metal on a wooden block

C. Clamp the metal securely to prevent it from spinning (Figure 104)

FIGURE 104


Lower Bit and Check Position
C-Clamp
Metal
Wooden Block

D. Put on safety goggles

E. Feed the bit down to the metal

F. Raise the bit slightly to see if you are drilling in the proper place

(NOTE: Metal may need to be adjusted.)

G. Lower bit and start drilling

H. Continue drilling, using cutting oil on the drill bit 2 or 3 inches above the work

BASIC HAND TOOLS
UNIT IV

JOB SHEET #13--OPERATE A CHAIN SAW

I. Tools and equipment

  A. Chain saw

  B. Operator's manual

  C. Protective clothing

    1. Close-fitting clothes

    2. Heavy-duty gloves

    3. Safety glasses or goggles

    4. Hard-toed shoes

    5. Earplugs

  D. Log supported along its entire length

II. Procedure

  A. Read operator's manual

  B. Check fuel

  C. Check oil level

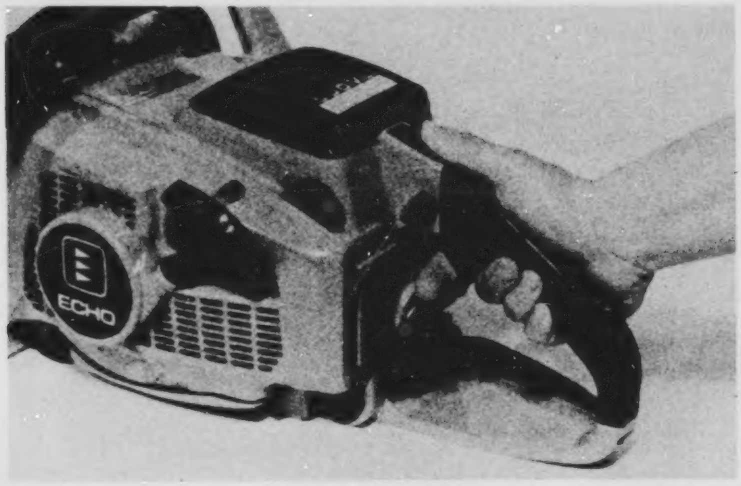
  D. Check chain tension according to manufacturer's recommendations

  E. Make sure bar on saw is tight

  F. Place saw on a clear, firm, and flat surface

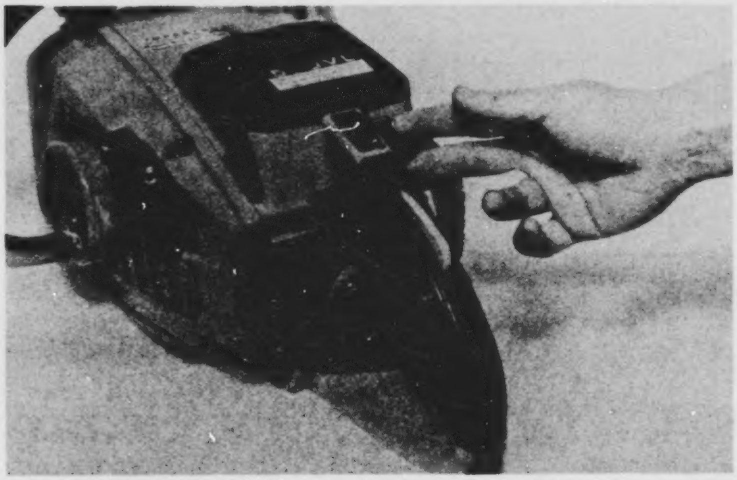
G. Move ignition/stop switch back to the START position (Figure 105)

FIGURE 105



H. Pull the choke button out to the closed position (cold engine only) (Figure 106)

FIGURE 106

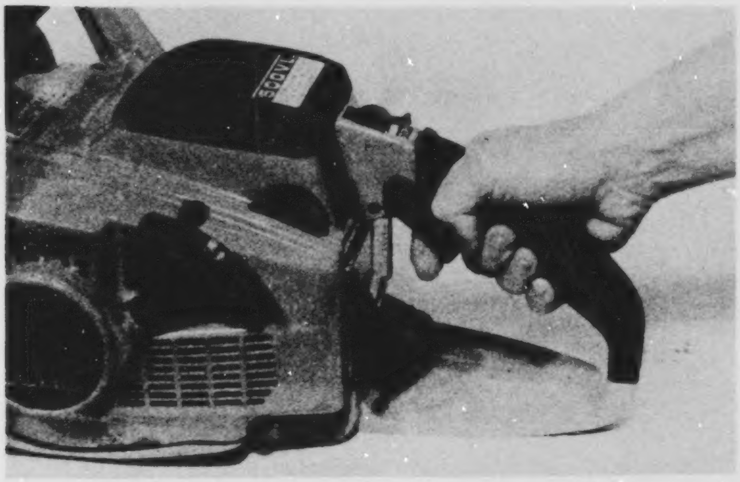


JOB SHEET #13

I. Squeeze the throttle trigger with your forefinger (Figure 107)

(NOTE: If saw is equipped with throttle catch, engage it at this time.)

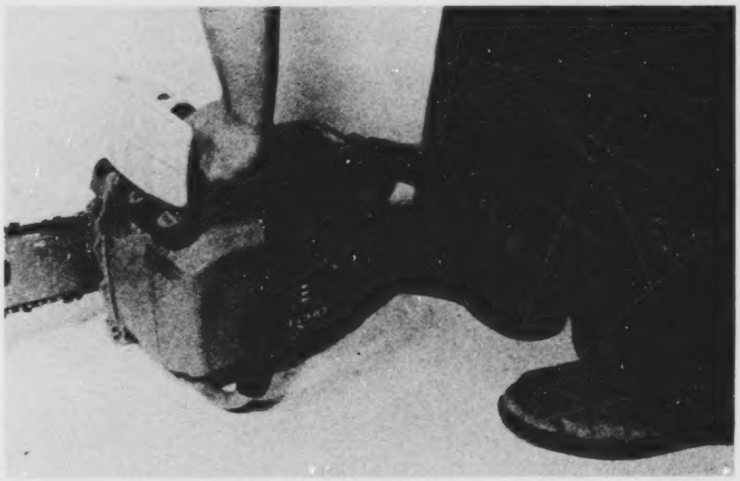
FIGURE 107



J. Put your right foot through the boot loop and hold the saw down firmly by the front handle (Figure 108)

(CAUTION: Keep all parts of your body clear of the bar and chain.)

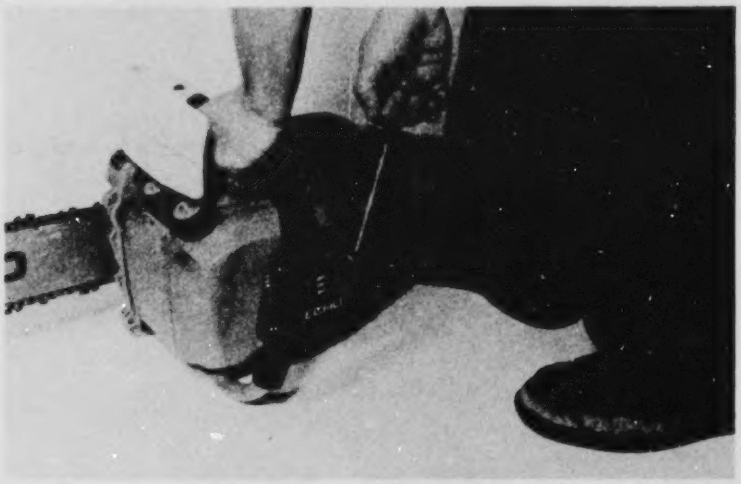
FIGURE 108



JOB SHEET #13

K. Pull the starter handle slowly until you feel the starter engage, then pull with a smooth, rapid, short-stroke motion (Figure 109)

FIGURE 109



L. Allow the starter rope to rewind slowly

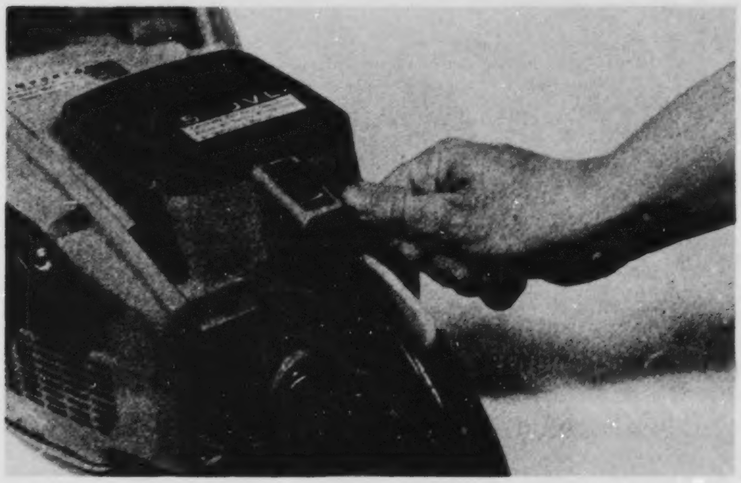
(NOTE: NEVER let the starter rope snap back from the extended position.)

M. Repeat until engine fires

N. Push the choke button in to the open position as soon as the engine fires (Figure 110)

(NOTE: If the engine fires, but does not continue to run, leave the choke pushed in to the open position, then pull the starter handle again. Repeat until the engine starts.)

FIGURE 110



JOB SHEET #13

O. Push the throttle in, get engine up to speed, then release to idle speed

(NOTE: If saw is equipped with throttle latch, release it at this time to allow engine to run at idle speed.)

P. Keep the engine running by pulling the choke button out slightly while squeezing and releasing the throttle trigger

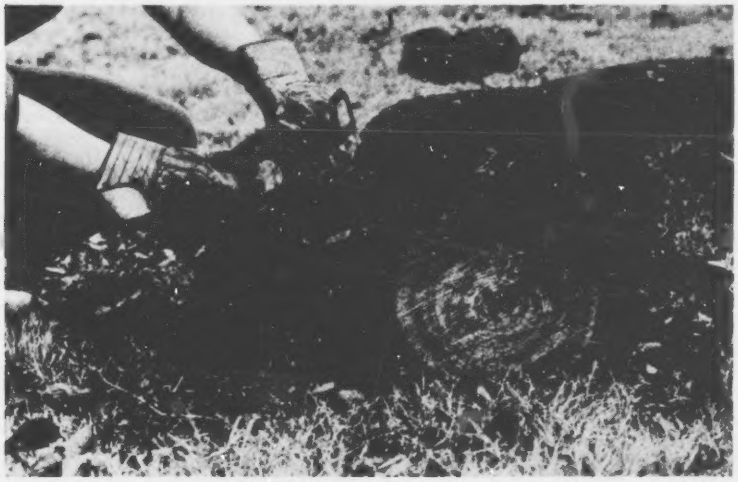
(NOTE: Keep squeezing and releasing until engine is running smoothly.)

Q. Push choke button in and allow the engine to idle until it is warmed up

(NOTE: Do not run the engine at full speed unless you are cutting wood.)

R. Apply saw blade to wood with handle against the wood (Figure 111)

FIGURE 111



JOB SHEET #13

S. Squeeze throttle trigger to cut

T. Start at the top of the log and overbuck, using a rolling motion back and forth; let the weight of the chain saw pull the blade down

(CAUTION: Do not apply pressure or force to the blade; let the weight of the blade move the saw. See Figures 112 and 113.)

FIGURE 112

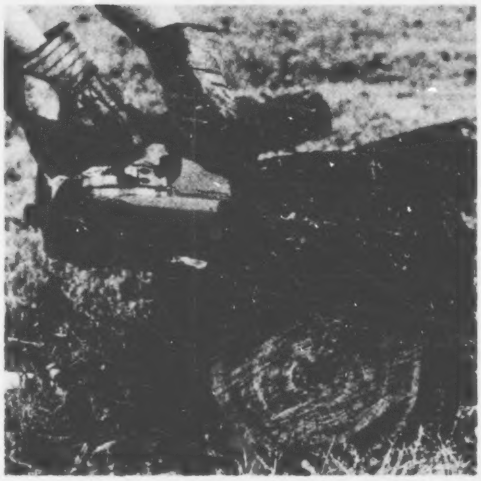
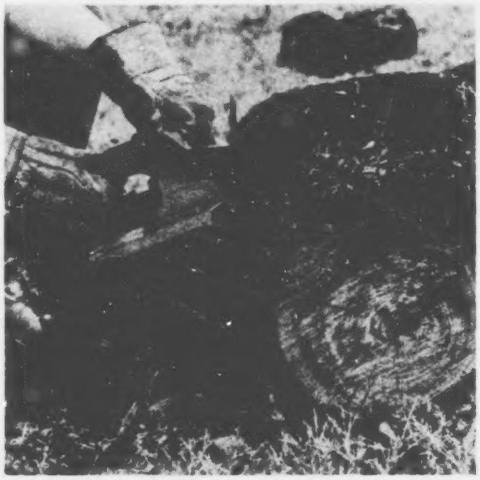


FIGURE 113



U. Cut log through, rolling it forward with your foot as needed

V. Make second and third cuts

W. Stop the chain saw by releasing the throttle trigger

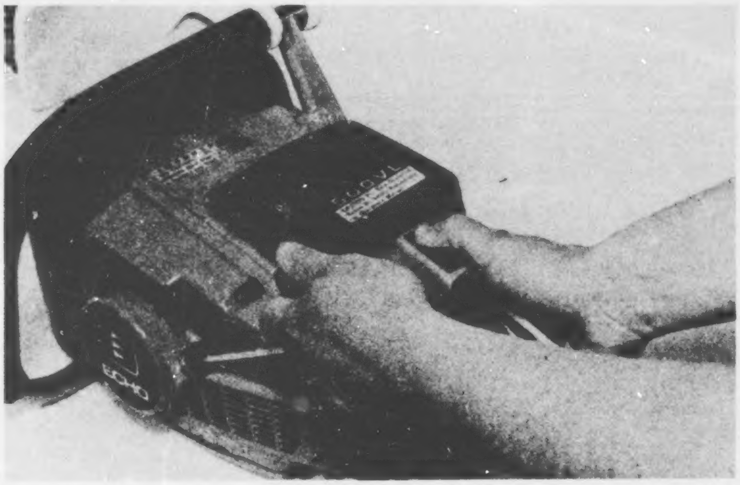
X. Allow engine to return to idle speed

Y. Place saw on a clear, firm, and flat surface

JOB SHEET #13

Z. Pull the starter handle out slowly about six inches and move the ignition/stop switch forward to the STOP position (Figure 114)

FIGURE 114



BASIC HAND TOOLS
UNIT IV

JOB SHEET #14--FELL A TREE

I. Tools and equipment

- A. Chain saw
- B. Tree, either green or dead

  (NOTE: Green wood will be easier to cut and will not dull chain saw blade as rapidly as dead wood.)

- C. Ax
- D. Protective clothing
  1. Close-fitting clothes
  2. Heavy-duty gloves
  3. Safety glasses or goggles
  4. Hard-toed shoes
  5. Earplugs
- E. Operator's manual

II. Procedure

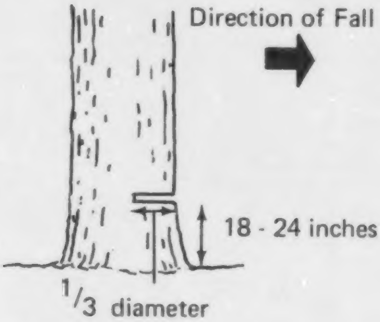
- A. Review operator's manual
- B. Select tree
- C. Walk around the tree, noticing direction of lean, ground slope, any trees which might interfere with the fall line, and wind direction
- D. Select the fall line
- E. Start chain saw and allow it to warm up
- F. Clear off branches or brush from the bottom of the tree

  (CAUTION: Slender material may catch the saw chain and be whipped toward you or pull you off balance.)

JOB SHEET #14

G. Make a straight cut 18-24 inches above the ground in the direction of fall about 1/3 the diameter of tree (Figure 115)

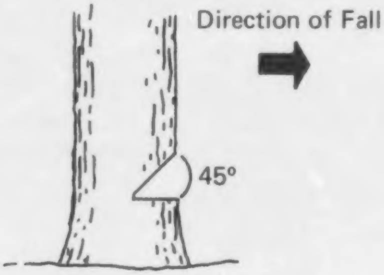
FIGURE 115


Direction of Fall
18 - 24 inches
1/3 diameter

Used with permission of the McCulloch Corporation.

H. Make a 45° cut starting 2-8 inches above the straight cut (depending on size of tree) and meeting straight cut (Figure 116)

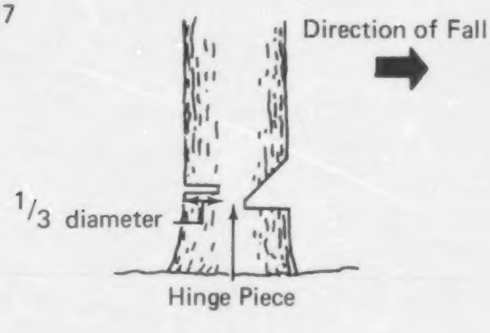
FIGURE 116


Direction of Fall
45°

Used with permission of the McCulloch Corporation.

I. Make a straight cut on opposite side of tree, toward top of notch about 1/3 diameter of tree (Figure 117)

FIGURE 117


Direction of Fall
1/3 diameter
Hinge Piece

Used with permission of the McCulloch Corporation.

JOB SHEET #14

(CAUTION: Do not cut through to the first notch. The remaining piece of wood will serve as a hinge to keep the tree from jumping back on you. If wood is rotten, the tree will have a tendency to jump back if stress is placed on it. Move back quickly as tree starts to fall.)

(NOTE: Alternate cuts may be made safely. An undercut wedge leaves the butt end of the log cut squarely across [Figure 118]. A wedge is cut from two 45° angles [Figure 119]. When the diameter is greater than the bar length, make two cuts [Figure 120].)

FIGURE 118

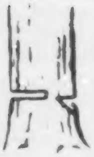


FIGURE 119

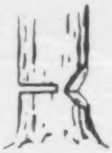
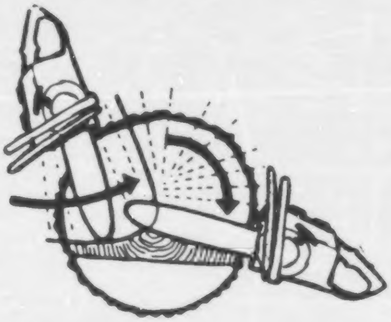


FIGURE 120



Used with permission of the McCulloch Corporation.

J. Remove chain saw and release trigger as soon as tree starts to fall; step back away from the fall line

K. Remove smaller limbs and branches with an ax

L. Cut larger branches by overbucking

(NOTE: Do not cut branches supporting felled tree.)

M. Buck into lengths, removing supporting branches after each section is cut

(NOTE: If you get tired, lose feeling in your hands and fingers, or your muscles get tired, stop and rest.)

N. Stop saw and check condition of blades and chain tension

O. Restart saw and finish bucking

P. Stop saw properly

Q. Stack or load wood

BASIC HAND TOOLS
UNIT IV

JOB SHEET #15--SHARPEN AND ADJUST A CHAIN SAW BLADE

I. Equipment and materials

- A. Chain saw with dull blade
- B. Operator's service manual
- C. Correct size chain saw file
- D. File guide
- E. Flat file
- F. Combination wrench set
- G. Standard or Phillips screwdriver set
- H. Recommended chain oil
- I. Safety glasses
- J. Leather gloves

II. Procedure for sharpening blades

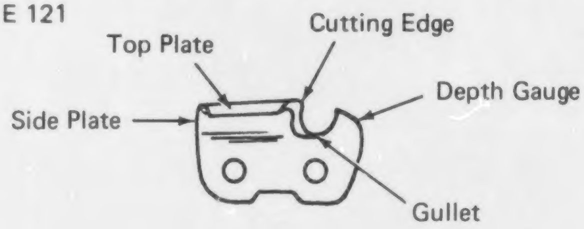
(NOTE: Blades should be sharpened after a day's cutting. In sandy conditions or with abrasive wood, they will have to be sharpened once or twice during the cutting operation. As blades dull, the cutting edge becomes shiny. Blade is sharp when no more shiny surface remains.)

- A. Put on safety glasses and gloves
- B. Leave chain on saw or place in a chain filing vise

  (NOTE: If chain is to be sharpened on saw, disconnect spark plug wire and ground it to the engine block.)

- C. Use a chain saw file of the proper size and a file guide marked for the correct filing angle (Figure 121)

FIGURE 121



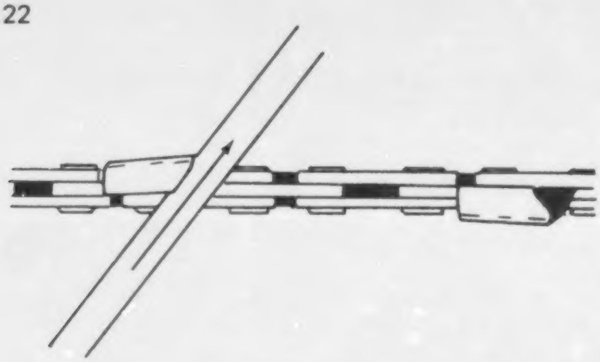
Used with permission of the McCulloch Corporation.

JOB SHEET #15

D. Hold the file at the correct top filing angle (approximately 30°)

E. Apply pressure against the face of the tooth and push the file toward the outside (Figure 122)

FIGURE 122



F. Release pressure on the cutting edge on the return stroke

(NOTE: Do not file on the back stroke.)

G. Repeat sharpening stroke until tooth is sharp

(NOTE: Use the same number of strokes [2-3] on each tooth to keep all teeth the same length.)

H. Drop file into gullet and clean out with a few light strokes

(NOTE: Do not touch cutting edge of the tooth.)

I. Sharpen all teeth on one side of the chain before sharpening teeth on the other side

III. Procedure for setting depth gauge

(NOTE: If chain is gauged with bar in saw, ground spark plug wire.)

A. Put on safety glasses

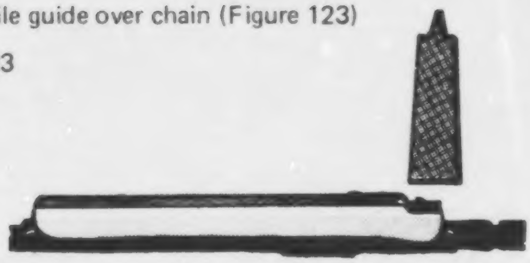
B. Check service manual for recommended depth

(NOTE: Manufacturers recommend specific depths at which the chain should be set. Cutting condition and wood conditions will determine what depth may be used.)

JOB SHEET #15

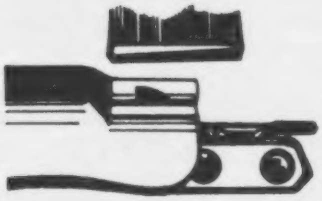
C. Place file guide over chain (Figure 123)

FIGURE 123



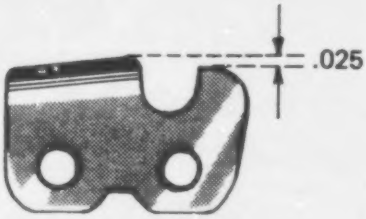
D. File off that portion of the depth gauge above the file guide (Figure 124)

FIGURE 124



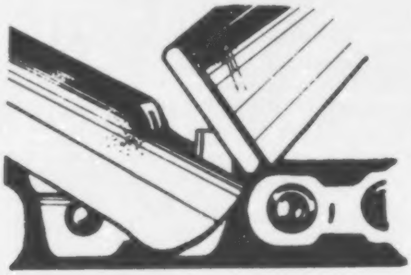
(NOTE: Be certain that all depth gauges are filed the same. Check depth gauge every third or fourth sharpening. See Figure 125.)

FIGURE 125



E. Round off front corner, using tilted file guide to protect top of cutter (Figure 126)

FIGURE 126



F. Repeat until all depth gauges have been worked

JOB SHEET #15

IV. Procedure for adjusting chain tension

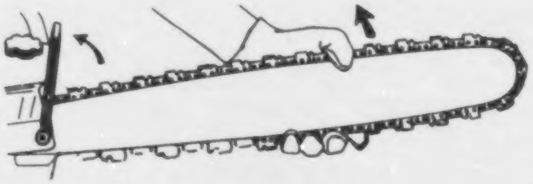
(NOTE: Remove spark plug wire and ground it to the block.)

A. Put on leather gloves

(CAUTION: Leather gloves should be worn at all times to protect against the sharp edges of the chain.)

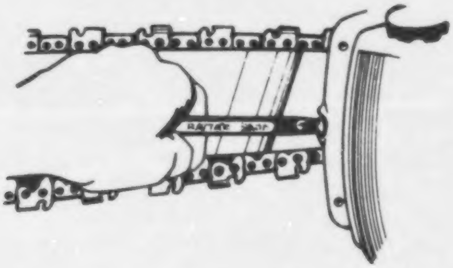
B. Loosen bar nuts (Figure 127)

FIGURE 127



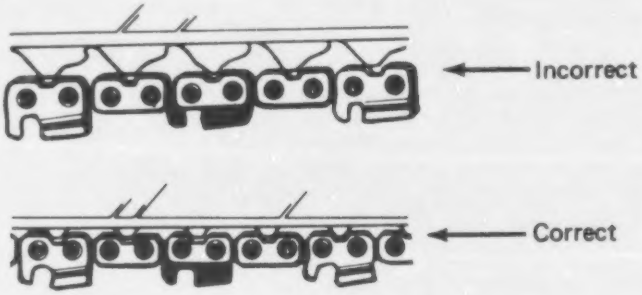
C. Adjust tension screw if saw is so equipped (Figure 128)

FIGURE 128



(NOTE: Tighten until chain just touches bottom bar rails. Pull up on chain to make sure it will not come out of groove. See Figure 129.)

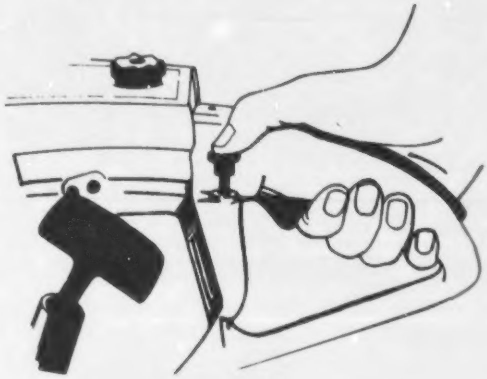
FIGURE 129



JOB SHEET #15

D. Oil the chain (Figure 130)

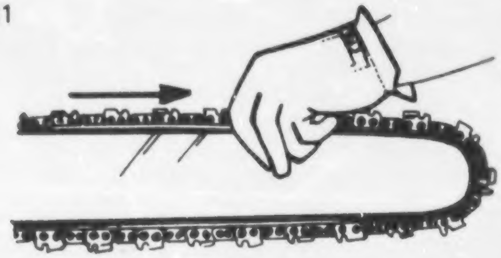
FIGURE 130



E. Rotate chain around bar (Figure 131)

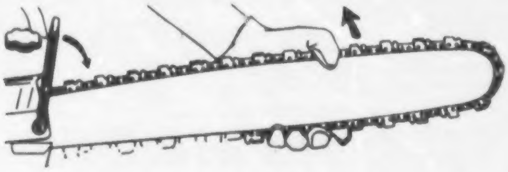
(NOTE: Be sure it fits sprocket and bar.)

FIGURE 131



F. Hold bar tip up, and tighten nuts (Figure 132)

FIGURE 132



G. Rotate chain again to make sure it moves freely

BASIC HAND TOOLS
UNIT IV

TEST

NAME ____________________________________ SCORE ________________

1. State the purpose of tools--____

____

2. Match terms associated with basic hand tools to their correct definitions. Write the correct numbers in the blanks.

______a. Distance across a round object

______b. Sharp edge left on a metal part from filing or sharpening

______c. The pointed end of a file

______d. Size of abrasive

______e. Removing the wire edge with a fine abrasive stone after a tool has been ground

______f. To cut a log into pieces or lengths

______g. Amount of material consumed each time a saw makes a cut

______h. Action of a tool jumping or jerking up or backwards

______i. Pushing and pulling a file sideways along the work

______j. To cut down a tree

______k. Distance around a round object

______l. Small bits of materials thrown from cutting, drilling, or sawing

______m. Cutting the grinding wheel circumference to make all points the same distance from the center

______n. Cutting surface or agent on a grinding wheel

______o. Making new, sharp cutting agents on the face of the grinding wheel by removing worn surface

______p. Outside circumference

1. Burr
2. Grit
3. Kerf
4. Drawfiling
5. Abrasive
6. Dressing
7. Tang
8. Buck
9. Circumference
10. Trueing
11. Face of grinding wheel
12. Honing
13. Diameter
14. Fell
15. Chips
16. Kickback

TEST

3. Match basic tools for in-shop maintenance to their correct uses. Write the correct numbers in the blanks. Tools and uses are continued on the next three pages.

______a. Used to hold parts for sawing, filing, and other hand operations

______b. Used to shape metal, to remove large amounts of material quickly

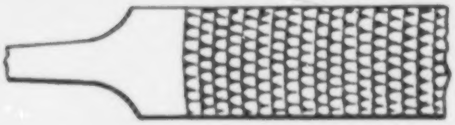
______c. Used to saw metal parts (especially pipe) to size or shape by hand

______d. Used to finish a sharp edge; gives a smooth finish

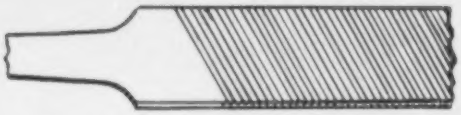
______e. Used to file soft metals quickly

______f. Used for chipping flat surfaces and for cutting rivet heads and thin sheet metal

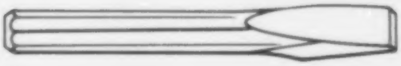
1. Rasp file



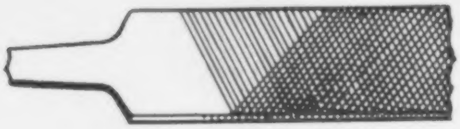
2. Single-cut file



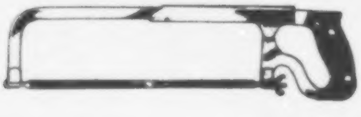
3. Cold chisel



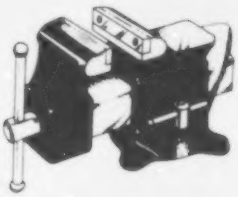
4. Double-cut file



5. Hacksaw



6. Bench vise



TEST

______g. Used to tighten or loosen hexagonal head bolts or nuts of a particular size; prevents slippage

______h. Used to tighten or loosen nuts or bolts; fits many sizes

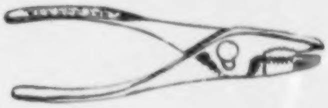
______i. Used for holding and gripping small articles in situations where it may be inconvenient or impossible to use hands

______j. Used to tighten or loosen square or hexagonal head bolts or nuts of a particular size; prevents slippage

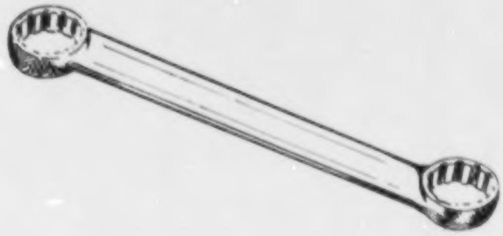
______k. Used to tighten or loosen bolts and nuts with hexagonal heads, usually in places where space is limited

______l. Used to tighten or loosen square or hexagonal head bolts or nuts of a particular size

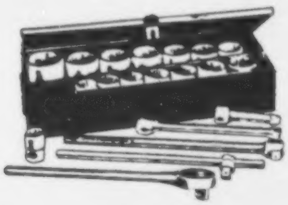
7. Standard pliers (slipjoint pliers)



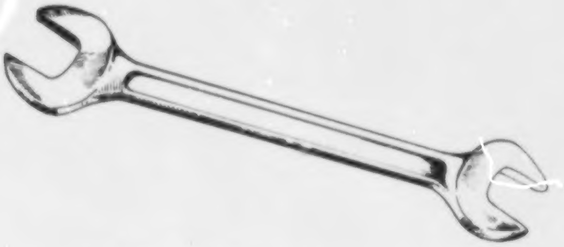
8. Box wrench



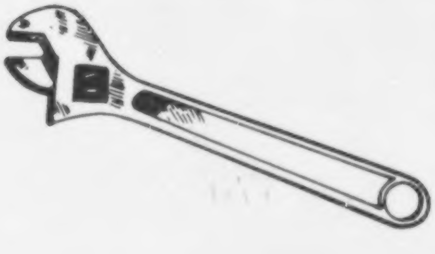
9. Socket set (ratchet)



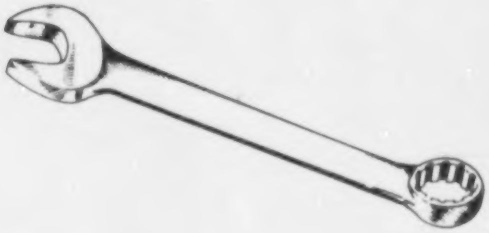
10. Open-end wrench



11. Adjustable wrench (crescent wrench)



12. Combination wrench (open- and box-end)



TEST

______m. Used to drive and remove nails

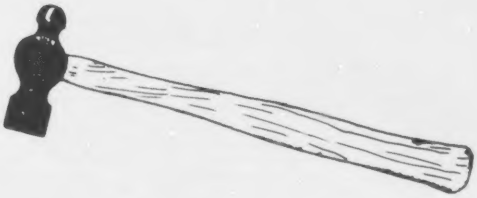
______n. Used to tighten or loosen screws and bolts which have a slotted head

______o. Used to drive a chisel or broaden (flair) the head of a rivet or pin

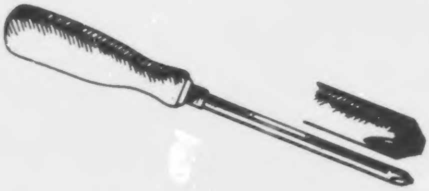
______p. Used to remove bolts and screws whose heads have been broken off or damaged

______q. Used to tighten or loosen screws and bolts which have a head with four slots that slant downward

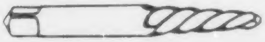
13. Ball peen hammer



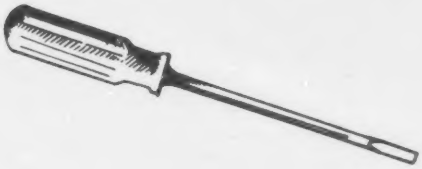
14. Phillips screwdriver



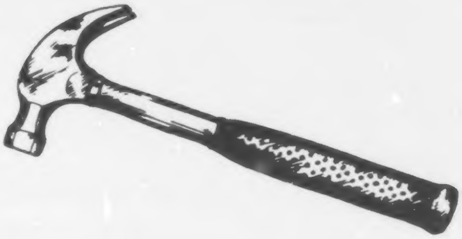
15. Screw extractor ("easy out")



16. Standard screwdriver



17. Claw hammer



TEST

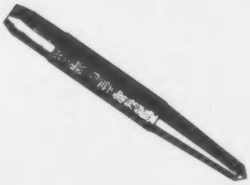
______r. Used to clean a file

______s. Used when cleaning up work area; has long, fine bristles that will clean up fine chips

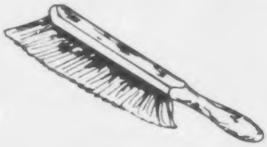
______t. Used to cover the tang of a file

______u. Used to mark the location of a hole before drilling by making a dent in the surface of the material

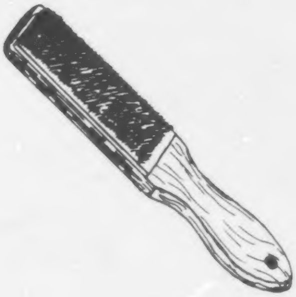
18. Punch



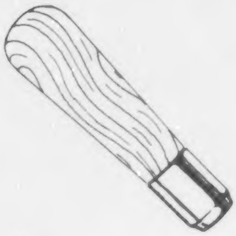
19. Counter or bench brush



20. File card



21. File handle



TEST

4. Match basic tools for field maintenance to their correct uses. Write the correct numbers in the blanks. A blank may have more than one answer. Tools and uses are continued on the next two pages.

______a. Used to trim sides of holes for patching asphalt, breaking off edges of asphalt, and loosening rocks

______b. Used for driving small signposts, breaking rocks, and driving stakes

______c. Used to dislodge rocks, loosen dirt, and lift equipment or rocks

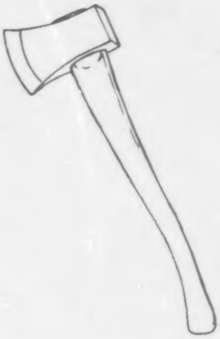
______d. Used to drive delineator posts or steel fence posts into the ground

______e. Used for chopping brush, and cutting limbs and trees

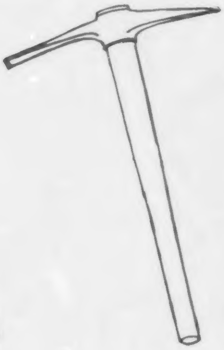
______f. Used for clearing small brush, digging, chopping, digging in asphalt, and squaring up holes

______g. Used to dig postholes

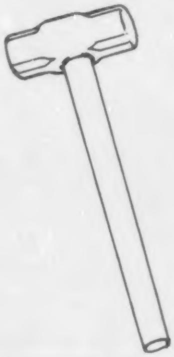
1. Ax



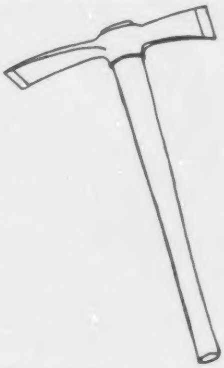
2. Pick



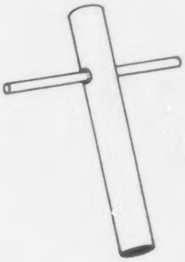
3. Sledgehammer



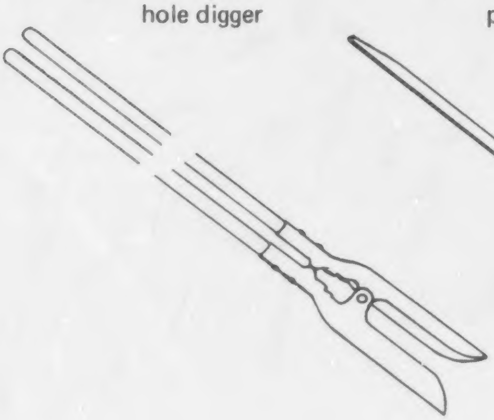
4. Mattock



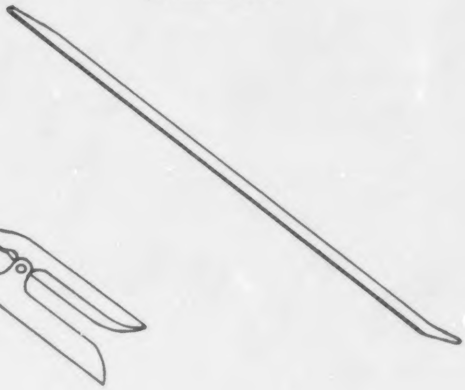
5. Fence-post driver



6. Hand post-hole digger



7. Pry bar (or pointed bar)



TEST

______h. Used for shop cleanup, asphalt patching cleanup, and spreading chips or sand

______i. Used for handling gravel and rocky fill, digging holes, and spreading material

______j. Used for raking weeds and grass

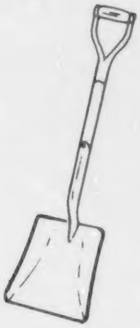
______k. Used for cutting weeds and mixing concrete

______l. Used for smoothing, handling sand, cleaning ditches, spreading materials, and leveling

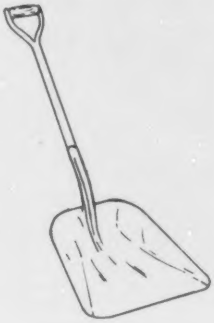
______m. Used to cut grass or weeds, particularly around guardrails, bridge abutments, and culverts

______n. Used for feathering asphalt to a smooth finish, patching large overlays, and placing cold asphalt mix

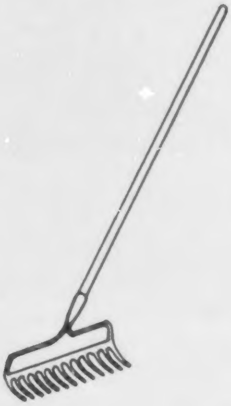
8. Square-point shovel



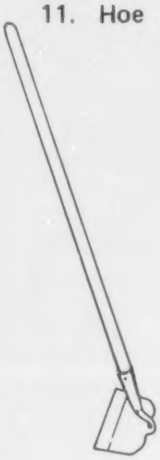
9. Scoop shovel



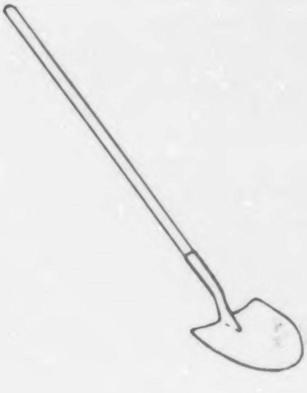
10. Garden rake



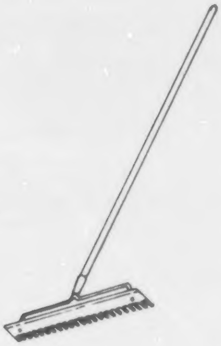
11. Hoe



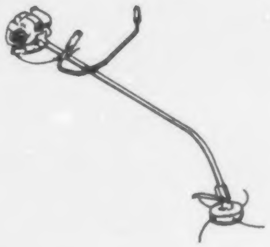
12. Round-point shovel



13. Asphalt rake



14. Weed cutter



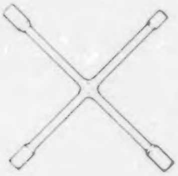
TEST

______o. Used to repair fences, cut wire, and stretch barbed wire

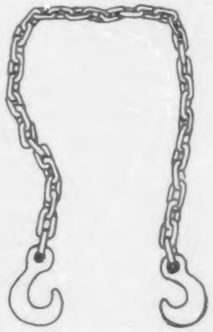
______p. Tire-changing tools

______q. Used for towing

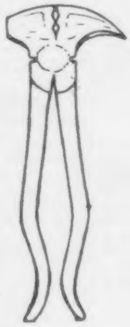
15. Lug wrench



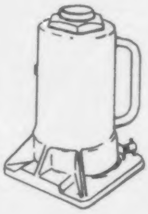
16. Log chain



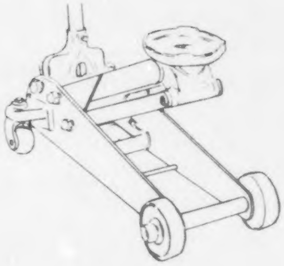
17. Fencing pliers



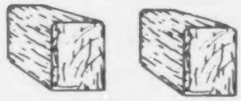
18. Hydraulic jack



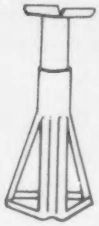
19. Floor jack



20. Blocks



21. Jack stand



TEST

5. Match power tools to their correct uses. Write the correct numbers in the blanks. A blank may have more than one answer.

______a. Used for clearing brush, cutting signposts, cutting timbers for wood bridges, and cutting guardrail posts

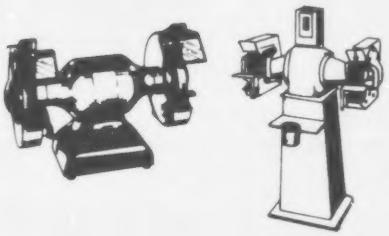
______b. Used to produce round holes in material by using twist drills and other types of cutting tools

______c. Used for drilling holes, particularly in signposts

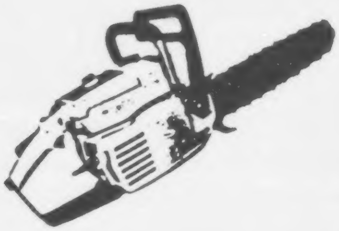
______d. Used for sharpening blades, grinding and shaping tools, and cleaning metal parts

______e. Used for cutting posts and cutting out signs

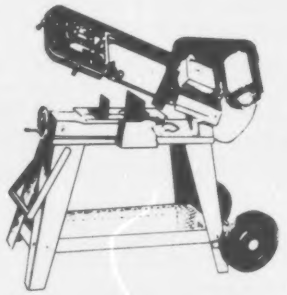
1. Grinder (bench or pedestal)



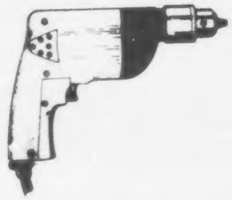
2. Chain saw



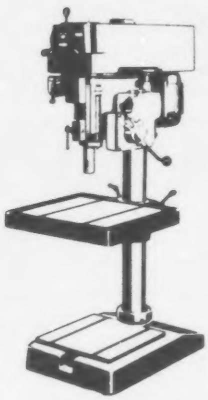
3. Band saw



4. Electric drill



5. Drill press



TEST

6. Select from the following list general rules for using tools. Write an "X" in the blank before each correct answer.

   ______a. Dispose of broken tools that cannot be repaired

   ______b. Remove guards from grinder for specific jobs

   ______c. Always use a tool to do work for which it was designed

   ______d. Keep cutting edges sharp

   ______e. Wear safety gloves for all grinding and cutting work

   ______f. Hone sharp edges off files and blades

   ______g. Stay alert any time you use hand tools or power tools

   ______h. Always store tools properly

   ______i. Protect tools from rust; oil after using

   ______j. Use any heavy tool as a hammer

   ______k. Repair broken or damaged tools promptly

   ______l. When necessary, use a screwdriver in place of a punch or chisel

   ______m. Store sharp or pointed tools in a place where you will not stab yourself with them

   ______n. Use a shovel as a pry bar

   ______o. Use cheater bar on wrench to loosen tight nuts or bolts

   ______p. Wear safety goggles when required

   ______q. Inspect tools frequently to make sure they are in good working condition

   ______r. Keep a log of tool usage and conditions

   ______s. Keep all tools clean; wipe chips and grease off before storing

7. State rules for safe use of specific hand tools.

   a. Screwdrivers

      1) ____

      2) ____

TEST

b. Pliers

1) ____________________

2) ____________________

c. Hammers

1) ____________________

2) ____________________

3) ____________________

d. Wrenches

1) ____________________

2) ____________________

3) ____________________

4) ____________________

e. Hacksaw

1) ____________________

2) ____________________

3) ____________________

4) ____________________

5) ____________________

f. Files

1) ____________________

2) ____________________

g. Chisels

1) ____________________

2) ____________________

h. Bench vise

1) ____________________

2) ____________________

TEST

i. Shovels

1) ________________________________

2) ________________________________

j. Picks, mattocks, axes

1) ________________________________

2) ________________________________

3) ________________________________

k. Sledgehammer

1) ________________________________

2) ________________________________

3) ________________________________

l. Posthole digger

1) ________________________________

2) ________________________________

m. Jacks

1) ________________________________

2) ________________________________

3) ________________________________

8. Select from the following list safety rules for power tools. Write an "X" in the blank before each correct answer.

_____a. Do not smoke when refueling or checking fuel

_____b. Keep work areas clean

_____c. Remove grounding prong from plug if receptacle is two pronged

_____d. Do not leave a running machine unattended

_____e. Reposition piece while equipment is running

_____f. Check power line frequently for breaks in the insulation

_____g. Check machine and make all adjustments *before* turning on the power

_____h. Operate gasoline-engine-driven tools only in well-ventilated areas

TEST

_____i. Always wear gloves, safety shoes, safety glasses, and ear protection

_____j. Be sure that all guards are in place and functioning properly

_____k. Operate gasoline-engine-driven tools inside the shop

_____l. Do not look away or talk to others while operating a power tool

_____m. Clean power lines frequently

_____n. Use cheater bar on drill press for added pressure when bit is dull

_____o. Stop gasoline-engine-driven tools before refueling

_____p. Operate electric tools in wet areas

_____q. Repair or replace worn or damaged parts immediately

_____r. Make sure other persons are clear of tool before turning on the power

_____s. Stay away from hazardous jobs

_____t. Do not use any tool until you understand how to operate it

_____u. Leave tools within reach of other operators

_____v. Start and stop your own machine, and stay with it until it stops completely

_____w. Disconnect electrical power before oiling, cleaning, or adjusting

_____x. Remove watches, rings, or other jewelry which could get caught in moving parts

9. Select from the following list safety rules for power saws. Write an "X" in the blank before each correct answer.

_____a. Apply additional pressure on the blade to increase cutting power

_____b. Do not force blade when doing contour work; make sure blade will cut radius without bending

_____c. Test edge with fingers or gloves after cutting

_____d. Keep floor area clean and scraps picked up

_____e. Report broken parts or improper operation to your instructor or the proper authority

_____f. Never force or bind saw blade

_____g. Hold unstable material in place while the saw is started by another operator

TEST

______h. Never drop blade on the work or shove work into blade

______i. Remove guard when sawing large pieces

______j. Never touch or place hands close to moving saw blades

______k. Handle cut parts, which have sharp edges, with care until they have been deburred

______l. Shut off power between cuts

______m. Always use a wooden block to push piece through when cutting small parts

______n. Wear goggles to protect eyes from chips

______o. Wear gloves to protect hands

______p. Operate machine controls yourself

______q. Shut off power switches before adjusting any part on machine

______r. Never operate saw without covers and guards in place

______s. Complete cut before replacing stripped teeth

10. Select from the following list procedures for care and cleaning of power saws. Write an "X" in the blank before each correct answer.

______a. Clean coolant tanks and add or replace coolant as needed

______b. Replace brushes that clean chips from blade when brushes are worn

______c. Check and adjust power feed foot pedal regularly

______d. Clean saw filter screen daily; more often during heavy use

______e. Check guides and rollers frequently to make sure they are properly adjusted and working

______f. Clean chips from base and wheel guards daily

______g. Check all grease fittings and oil levels daily

______h. Clean chips from base and wheel guards weekly

______i. Check blade for set and missing teeth before using

______j. Clean saw filter screen weekly

TEST

11. Match safety rules for operating a bench or pedestal grinder to their correct terms. Write the correct numbers in the blanks.

______a. Wear a face shield or goggles over your safety glasses

______b. Can cause you or a friend to lose fingers or be seriously hurt

______c. Turn off power to stop grinder; move to side of grinding wheel until wheel has stopped

______d. Feed work into the wheel slowly and gradually; never shove it in

______e. Never operate a grinder with these removed

______f. Should be set a maximum of 1/16 inch from face of grinding wheel

______g. Do not grind brass, aluminum, copper, wood, plastic, and other such materials

______h. Must be flat and free of grooves or rounded edges

______i. Never wear these when operating the grinder

______j. Never grind here; the strength of the wheel is inward from face to center

______k. The tool or part you have been grinding is hot; do not touch it

______l. Should be worn for protection during prolonged grinder use

______m. Never set tool rest or spark breaker while wheel is turning

______n. Never try to repair; if the grinder does not work, notify instructor or proper authority

______o. Sharp point of the abrasive becomes dull and requires more pressure to cut

______p. Stand to one side until grinding wheel has reached its maximum rpm

1. Guards
2. Tool rest and spark breaker
3. Eyes
4. Horseplay
5. Pressure
6. Excessive vibration
7. Respirator
8. Adjustments
9. Nonferrous materials (materials not containing iron)
10. Starting
11. Face of grinding wheel
12. Glazing
13. Gloves
14. Side of wheel
15. Electrical switches
16. Burns

TEST

12. Select from the following list procedures for sharpening tools. Write an "X" in the blank before each correct answer.

_____a. Wear gloves

_____b. Dip tool in water frequently to keep it cool

_____c. Use oilstone or grindstone

_____d. Hold tool straight against wheel

_____e. Wear safety goggles

_____ . Hold tool *lightly* against the wheel to prevent overheating

_____g. Wait until sparks stop to grind tool

13. Match safety rules for operating a drill press to their correct terms. Write the correct numbers in the blanks. Rules and terms are continued on the next page.

_____a. Interrupt the feed occasionally to break up chips and clear the drill

_____b. Never operate the drilling machine with these removed

_____c. Long hair must be secured under a hat, in a hairnet, or tied back to keep it from getting caught in rotating parts

_____d. Should always be held in a vise or other device secured to the table; never try to hold it with your hands

_____e. Remove with a brush, never your hands

_____f. Keep work area and machine clean and free of slippery materials or chips to prevent accidents

_____g. Clean oil or coolant from drills and other tools and store them in the proper place

_____h. Always wear safety glasses to protect from chips

_____i. Remove before operating drill press to prevent possible accidents

1. Neatness
2. Drilling deep holes
3. Workpiece
4. Hair
5. Guards
6. Chips
7. Tools
8. Eyes
9. Watches and rings

TEST

_____j. Ease up when the drill is breaking through so that it will not grab and leave a big burr

_____k. Never pick up a drill, work, or any tool that you have been using, as it is hot and will burn; use a rag

_____l. Should be removed immediately after using; if left in place when machine is turned on, they will be thrown and can cause injury

_____m. Should never be used while machine is running, and should never be left on the table of a running machine

_____n. Should be kept clean and free of tools to eliminate accidents and possible damage to tools

_____o. Always wear close-fitting clothes which are less likely to get caught in revolving parts

_____p. Never clean or make adjustments while machine is running

10. Feed pressure
11. Hands
12. Chuck key or drill drift
13. Clothing
14. Machine in motion
15. Rags
16. Table

14. Arrange in order procedures for operating a drill press. Write a "1" before the first step, a "2" before the second step, and so on.

_____a. Ease up on the feed pressure as the drill breaks through the work

_____b. Use the correct drill for each operation

_____c. Apply cutting oil as needed

_____d. Lay out center location of each hole to be drilled

_____e. Set part in vise and tighten

_____f. Clean the machine after each use and put all tools away

_____g. Center punch location of holes

15. Select from the following list procedures for care and cleaning of a drill press. Write an "X" in the blank before each correct answer.

_____a. Check and adjust table locking bolts

_____b. Clean chips off table with a brush

TEST

______c. Clear any debris or accumulation from coolant nozzle

______d. Lubricate coolant pump every two to three weeks

______e. Never use a dull tool; it causes more friction and will ruin the tool

______f. Never crank speed selector when spindle is not turning

______g. Adjust belt guard before each use

______h. Check all oil levels before using

______i. Never shift gears when spindle is turning; shut off machine

______j. Check drive belts for proper tightness

16. State ten safety rules for operating a chain saw.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

17. State six procedures for operating a chain saw.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

TEST

18. Arrange in order procedures for felling a tree with a chain saw. Write a "1" before the first step, a "2" before the second step, and so on.

______a. Make a 45° angle cut 2-8 inches above the straight cut, meeting it at 1/3 the diameter of the tree

______b. Make a straight cut 18-24 inches off the ground on the side facing the direction of fall, 1/3 of the diameter deep

______c. LOOK at tree and determine best line of fall

______d. Make a straight cut directly behind the notch, toward the top of the angle cut

______e. SHOUT A WARNING

19. Match procedures for cutting felled logs to their correct operations. Write the correct numbers in the blanks. Answers may be used more than once.

______a. Avoid cutting into the dirt

______b. Overbuck 1/3 diameter of log to avoid splintering

______c. Overbuck to meet first cut and avoid pinching

______d. Keep the log off the ground

______e. Underbuck to meet first cut and avoid pinching

______f. Cut from the top (overbuck)

______g. Cut from the bottom (underbuck) 1/3 diameter of log to avoid splitting

______h. Do not remove supporting limbs until after the log is bucked into lengths

1. Cutting a log supported on both ends
2. Cutting a log supported along the entire length
3. Limbing
4. Cutting a log supported on one end

(NOTE: Test questions 20-26 list assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

20. Complete hand tool safety test.

21. Complete power tool safety test.

22. Complete power saw safety test.

23. Complete grinder safety test.

24. Complete drill press safety test.

TEST

25. Complete chain saw safety test.

26. Demonstrate the ability to

    a. Drawfile a flat surface.

    b. Use a hand hacksaw.

    c. Replace a hammer handle.

    d. Dig a hole with a hand shovel.

    e. Spread sand or asphaltic material with a shovel.

    f. Dig a hole with a hand posthole digger.

    g. Cut flat metal with a cold chisel.

    h. Dress a grinding wheel.

    i. Reshape a cold chisel.

    j. Reshape a screwdriver.

    k. Grind a drill bit.

    l. Drill holes with a drill press.

    m. Operate a chain saw.

    n. Fell a tree.

    o. Sharpen and adjust a chain saw blade.

BASIC HAND TOOLS
UNIT IV

ANSWERS TO TEST

1. To allow the operator to perform a variety of maintenance procedures quickly, safely, and effectively

2. a. 13
b. 1
c. 7
d. 2
e. 12
f. 8
g. 3
h. 16
i. 4
j. 14
k. 9
l. 15
m. 10
n. 5
o. 6
p. 11

3. a. 6
b. 4
c. 5
d. 2
e. 1
f. 3
g. 8
h. 11
i. 7
j. 12
k. 9
l. 10
m. 17
n. 16
o. 13
p. 15
q. 14
r. 20
s. 19
t. 21
u. 18

4. a. 2
b. 3
c. 7
d. 5
e. 1
f. 4
g. 6
h. 9
i. 12
j. 10
k. 11
l. 8
m. 14
n. 13
o. 17
p. 15, 18, 19, 20, 21
q. 16

5. a. 2
b. 5
c. 4
d. 1
e. 3

6. a, c, d, g, h, i, k, m, p, q, s

ANSWERS TO TEST

7. a. Answer should include any two of the following

    1) Never use a screwdriver as a chisel because such use will damage the screwdriver

    2) Never hold work while using a screwdriver; lay it on a bench or hold it in a vise; if the screwdriver slips, it can cause a stab wound

    3) Always use a screwdriver that fits the head of the screw, or you will damage the screw or screwdriver

   b. Answer should include any two of the following

    1) Do not use pliers to loosen or tighten a bolt or nut; they will damage the head

    2) Never use pliers to grip finished surfaces because the teeth will score the work

    3) If you must use pliers on a bolt or nut, use locking pliers that will not slip as easily

   c. Answer should include any three of the following

    1) Never use a hammer that has a split handle or loose head; the head may break off, causing injury or damage

    2) Never use a hammer on precision parts

    3) Never strike two hard surfaces together; a piece may break off one of them and hurt someone or damage the parts

    4) Hold the handle close to the end to increase the lever arm and produce a more effective blow

    5) Hold the hammer at such an angle that the face of the hammer and the surface of the object being hit will be parallel

   d. Answer should include any four of the following

    1) Select the correct size and type of wrench for each job

    2) Do not extend wrench handle with pipe or other device

    3) Do not use an open wrench to free a "frozen" nut or to do the final tightening of a hex nut

    4) Pull on the wrench--do not push

    5) Tighten in a clockwise direction-- ↻

    6) Loosen in a counterclockwise direction-- ↺

ANSWERS TO TEST

e. Answer should include any five of the following

1) Place material in vise grip close to vise jaws
2) Use correct blade for material being cut
3) Blade teeth should point forward
4) Blade should be rigid and tight
5) Wear safety glasses
6) Use less pressure just before blade cuts through material so that your hands will not strike vise or material
7) Use strong, steady strokes directed away from yourself
8) Use the entire length of the blade in the stroke
9) Cut thin, flat pieces across the surface so that several teeth are cutting at all times

f. Answer should include any two of the following

1) To prevent possible stab wounds from the spearlike point (tang), never use a file without a handle
2) Never use a file as a pry bar; it will break and can cause injury
3) When filing, apply pressure on *forward* stroke only

g. 1) Never use a chisel with a mushroomed head, as the head can chip off and cause injury; grind the head smooth

2) When using a chisel for chipping, always chip *away* from yourself and others

h. Answer should include any two of the following

1) Always clamp work well in the jaws
2) Do not use a cheater bar or hammer to tighten vise
3) Never hammer on vise guides; the casting will not stand the force

i. 1) Handles should be free of splinters, cracks, and splits

2) Blade should be sharp and free of jagged and split edges

ANSWERS TO TEST

j. Answer should include any three of the following

   1) Handles should be free of splinters, splits, and cracks

   2) Head should be firmly affixed to handle

   3) Areas in back and to sides of work area must be clear when swinging

   4) These tools should not be used to strike metal or to drive other tools

k. Answer should include any three of the following

   1) Avoid rebound toward other workers; head will bounce after the strike

   2) Handle should be free of splinters, splits, and cracks

   3) Object being driven should be between the swing of the tool and your feet and legs

   4) Be sure you have enough room for the swing

   5) Sledgehammer should not be used to strike a hammer, another sledgehammer, or a maul

l. Answer should include any two of the following

   1) Blade should be sharp and free of jagged and split edges

   2) Keep toes turned out away from the blades

   3) Grip should be such that you do not bang your knuckles together

m. Answer should include any three of the following

   1) Select jacks heavy enough to raise and hold load

   2) Place jack on firm, level foundation, adequate to support the load

   3) Place jack in line with vertical movement of load

   4) Securely block load before removing jack

   5) Lubricate frequently

8. a, b, d, f, g, h, j, l, o, q, r, t, v, w, x

9. b, d, e, f, h, j, k, m, n, p, q, r

10. a, b, d, e, f, g, i

ANSWERS TO TEST

11. a. 3
b. 4
c. 6
d. 5
e. 1
f. 2
g. 9
h. 11
i. 13
j. 14
k. 16
l. 7
m. 8
n. 15
o. 12
p. 10

12. b, c, e, f

13. a. 2
b. 5
c. 4
d. 3
e. 6
f. 1
g. 7
h. 8
i. 9
j. 10
k. 11
l. 12
m. 15
n. 16
o. 13
p. 14

14. a. 6
b. 1
c. 5
d. 2
e. 4
f. 7
g. 3

15. b, e, f, h, i, j

16. Answer should include any ten of the following

a. Read the operator's manual thoroughly

b. Do not attempt operations beyond your ability or experience

c. Wear close-fitting and protective work clothing

d. Start the saw on firm ground, not on your leg or knee

ANSWERS TO TEST

e. Never operate a chain saw when you are tired

f. Use a firm grip with thumbs and fingers encircling the chain saw handles

g. Be alert for kickback

h. Do not fell a tree during high or changing winds

i. Plan a safe exit from a falling tree or limbs

j. Do not cut in awkward positions

k. Be sure of your footing

l. Avoid prolonged operation of the chain saw, and rest often

m. Be alert for springback when cutting a limb or trunk that is under tension

n. Use extreme caution when cutting small-sized brush and saplings

o. NEVER transport saw with the chain running

p. Do not allow any other person or animal close to a running saw or a tree being felled

17. Answer should include any six of the following

a. Read the operator's manual thoroughly

b. Hold saw firmly with both hands, with thumbs and fingers encircling saw handles

c. Cut at high engine speeds only

d. Preplan a safe exit from a falling tree or limbs

e. Do not let the chain saw dig into dirt

f. Keep chain well lubricated

g. Test chain brake before cutting

h. Sharpen or touch up blade as needed during use

i. Check blade tension periodically

18. a. 4
b. 3
c. 1
d. 5
e. 2

ANSWERS TO TEST

19. a. 2
    b. 1
    c. 4
    d. 3
    e. 1
    f. 2
    g. 4
    h. 3

20. Evaluated to the satisfaction of the instructor
21. Evaluated to the satisfaction of the instructor
22. Evaluated to the satisfaction of the instructor
23. Evaluated to the satisfaction of the instructor
24. Evaluated to the satisfaction of the instructor
25. Evaluated to the satisfaction of the instructor
26. Performance skills evaluated to the satisfaction of the instructor

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT V

UNIT OBJECTIVE

After completing this unit, the student should be able to load and unload equipment. This knowledge will be shown by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with loading, lashing, and unloading equipment to their correct definitions.
2. State safety precautions for loading and moving equipment.
3. List types of equipment used to move equipment.
4. Select from a list devices used to load equipment.
5. State reasons for side loading equipment.
6. List precautions for side loading.
7. Discuss why and how pavement should be protected.
8. Select from a list steps in lashing equipment.
9. Demonstrate the ability to
    a. Load dozer from rear.
    b. Unload dozer from rear.
    c. Winch a load.

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT V

SUGGESTED ACTIVITIES

I. Suggested activities

   A. Order materials planned to supplement unit--Film--*Safe Side Clyde.* Color, 30 minutes, 16 mm, University of Arizona, 1969. Available from University of Arizona, Division of Media and Instructional Services, Film Library, Tucson, Arizona 85706. Phone (602)626-3282.

   (NOTE: This film concerns Job Corps enrollees at the National Forest Job Construction Center, and discusses attitudes toward on-the-job safety by doing as told, thinking ahead, and not taking chances. Film discusses correct clothing, proper use of tools, handling of heavy construction equipment, and looking out for other workers.)

   B. Provide students with objective sheet.

   C. Provide students with information and job sheets.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Provide alternate jobs if those in job sheets are not practical.

   EXAMPLES: Load, lash, and unload materials and small equipment such as a concrete saw, portable vibrator-compactor, or small roller.

   (NOTE: This unit is intended to train transport operators as well as new operators. If students cannot operate the tractor or dozer, have experienced operator run equipment and have students complete only the lashing and unlashing sections of the job sheets.)

   H. Give test.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Job sheets

      1. Job Sheet #1--Load Dozer from Rear

      2. Job Sheet #2--Unload Dozer from Rear

      3. Job Sheet #3--Winch a Load

SUGGESTED ACTIVITIES

- E. Test
- F. Answers to test

III. Unit references

A. *Cableco Catalog No. 950-5.* Los Angeles, California: American Hoist and Derrick Company, Cableco, 1968.

B. Hendrix, Laborn J., "Bud." *Heavy Equipment Operator Instructional Materials,* Vol. I. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and Associated General Contractors of America, 1981.

C. Nichols, Herbert L., Jr. *Moving the Earth,* 3rd ed. Greenwich, Connecticut: North Castle Books, 1976.

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT V

INFORMATION SHEET

I. Terms and definitions

A. Cribbing--To line or support with timber framework

B. Grouser--Ridge or cleat across a track shoe; improves traction

C. Dolly--Unit consisting of a draw tongue, an axle with wheels, and a turntable platform to support a trailer gooseneck

D. Blocks--Wooden, triangular shapes to fit track or tires

E. Load binders--Levers that pull two grab hooks together and hold them by locking over center (Figures 1, 2, and 3)

EXAMPLES:

FIGURE 1

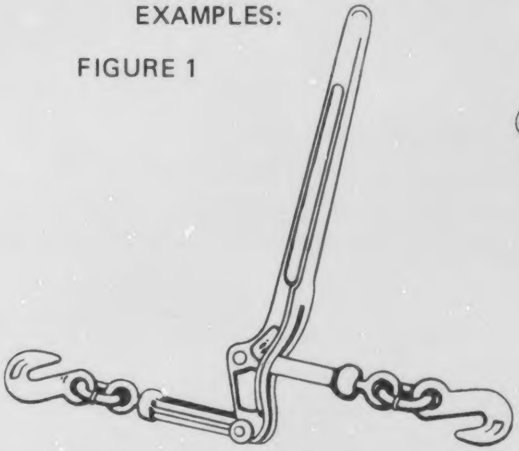


FIGURE 2

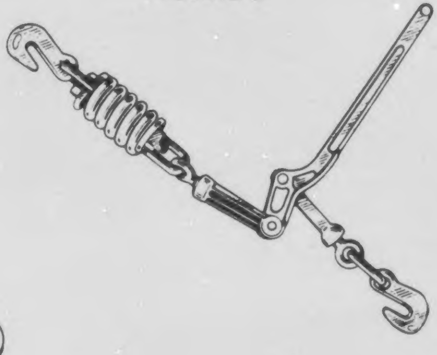
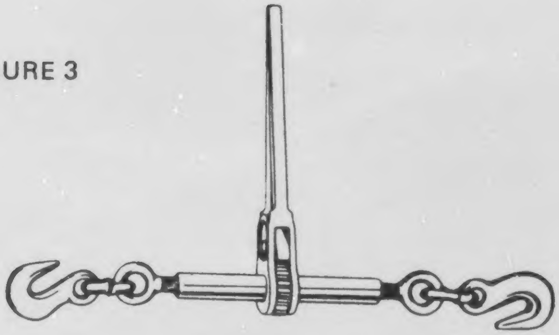


FIGURE 3



INFORMATION SHEET

F. Center of gravity--Point of balance where any additional movement will tip equipment

G. Cheater pipe--Extended pipe used with load binders for additional leverage

H. Mooring--Fixture or bracket which secures winch cable hook to tractor

II. Safety precautions for loading and moving equipment (Job Sheets #1 and #2)

(NOTE: Permits are required when moving equipment.)

A. Signal before moving

B. Use crawler blocks and safety chains

C. Use signal person when clearances are close

D. Never overload trailer

E. Know height, width, and weight of load

F. Use substantial ramp or blocks when loading

G. Set swing brake and/or lock

H. Be sure all loose gear, outrigger beams, and pads are secure

I. Follow manufacturer's instructions when towing

J. Travel with lights on

K. Use proper signs and warning flags

L. Do not exceed bridge load limits

M. Watch for narrow spots and low clearances

N. Allow for boom overhang and structure clearances when turning corners

O. Slow down when crossing obstacles

EXAMPLES: Bridge expansion joints, cattle guards, potholes

P. Watch height clearance when moving boom equipment

(NOTE: Uneven ground may cause boom to bob and weave enough to contact obstructions.)

Q. Tie down or cover rain cap

(NOTE: Wind will turn blades and heat turbocharger.)

INFORMATION SHEET

R. Allow for added length when turning, stopping, or passing

III. Types of equipment used to move equipment

(NOTE: Always use a trailer of sufficient size for the equipment you are hauling.)

A. Girder frame deck trailer with stationary gooseneck

B. Deck trailer with detachable gooseneck

C. Extra-heavy trailer with multiple dollies

D. Girder or I-beam trailer

E. Low-bed trailer (low-boy)

F. Tilt-bed trailer

G. Dump truck

H. Flatbed truck with tilting rollback bed

IV. Devices used to load equipment

A. Wood planks

B. Steel box or channels

C. Wood reinforced with steel plates or angles

D. Blocks

E. Cribbing timbers

F. Dirt banks

(NOTE: Loading often is simplified by backing or pulling the trailer alongside a bank or into a deep gutter.)

G. Self loaders

(NOTE: Large tractors can walk on a trailer from ground level, pulling the trailer down with its grousers.)

V. Reasons for side loading equipment

(NOTE: Side loading equipment should be used only on equipment designed for side loading.)

A. More convenient in small areas

INFORMATION SHEET

- B. Shorter and lighter ramps may be used
- C. Drop-deck models are lower at sides
- D. Sometimes only blocks are needed

VI. Precautions for side loading

- A. Do not lay ramps on edge of deck
- B. Be sure to block trailer before loading
- C. Take special care when loading large equipment from side; turning may be very difficult
- D. Be sure weight is distributed evenly
- E. Do not rest any part of load over exposed tires unless the part is high enough for tires to turn freely
- F. Be sure all machines are blocked and tied down when transporting
- G. Avoid loading in wet, muddy, or icy conditions

VII. Why and how pavement should be protected

- A. Why
  1. To prevent scuffing during turns
  2. To prevent crushing of asphalt pavements
  3. To prevent bruising of pavements
  4. To prevent digging in of grousers

     (NOTE: Many localities prohibit crawler equipment on streets.)
- B. How--Cover with
  1. Planking
  2. Layer of dirt
  3. Cribbing
  4. Mats
  5. Rubber tires

INFORMATION SHEET

VIII. Steps in lashing equipment (Job Sheets #1, #2, and #3)

A. Leave equipment in gear with clutch engaged and brakes locked

B. Place blocks at each end of both tracks or tires

C. Fasten chains from each corner of equipment to the D-loops on the trailer sides; or fasten chain to loop on one side of trailer, then over equipment to loop on other side and tighten

(NOTE: At least two of these chains should be tightened and locked with load binders.)

D. Place load binders on side of trailer where they can be seen from rear view mirror

E. Wrap end of chain around load binder to prevent binder from vibrating loose

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT V

JOB SHEET #1--LOAD DOZER FROM REAR

Equipment and materials

A. Dozer

B. Trailer

C. Ramps

D. Blocks

E. Chains

F. Load binders

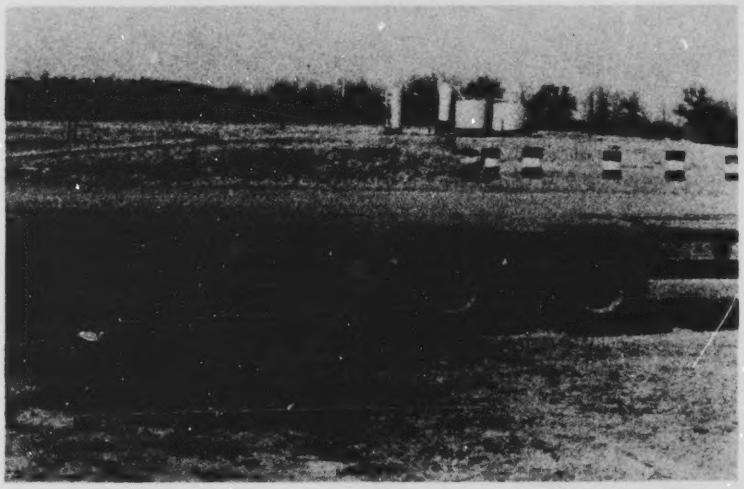
G. Cheater pipe

II. Procedure

A. Drop ramps to ground (Figure 4)

(NOTE: Place substantial supports under ramps if needed.)

FIGURE 4

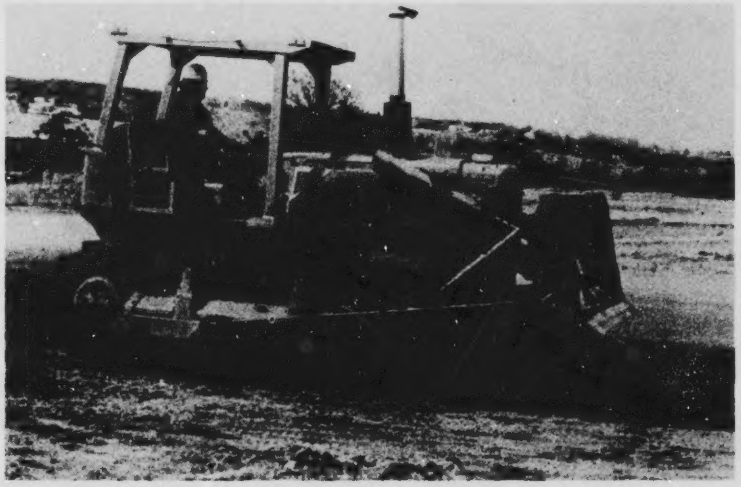


JOB SHEET #1

B. Pull dozer up to ramp (Figure 5)

(NOTE: Check to see that tracks line up with ramp.)

FIGURE 5



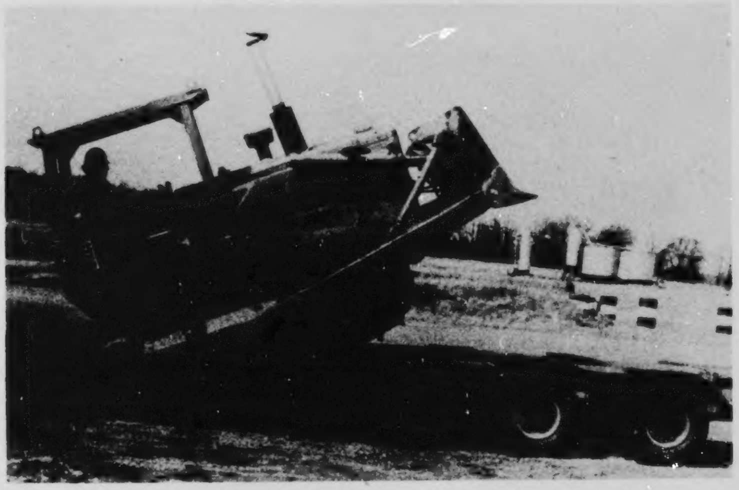
C. Select low gear and start up ramp very slowly and cautiously (Figure 6)

FIGURE 6

JOB SHEET #1

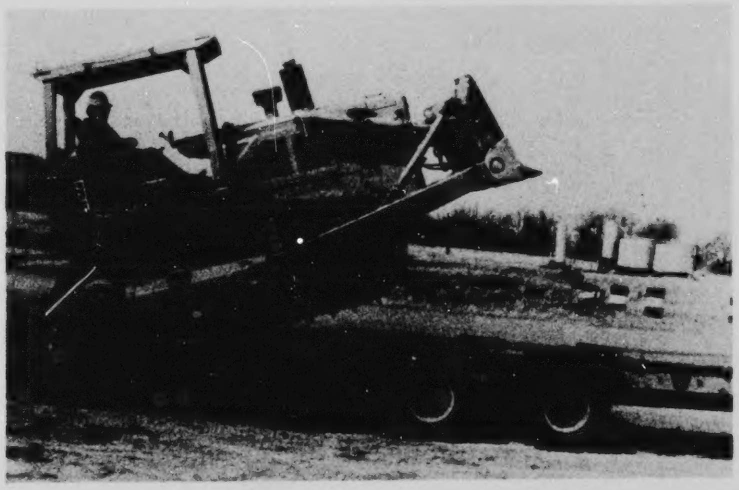
D. Continue moving up ramp (Figure 7)

FIGURE 7



E. When center of gravity is reached, move forward very cautiously to avoid jarring (Figure 8)

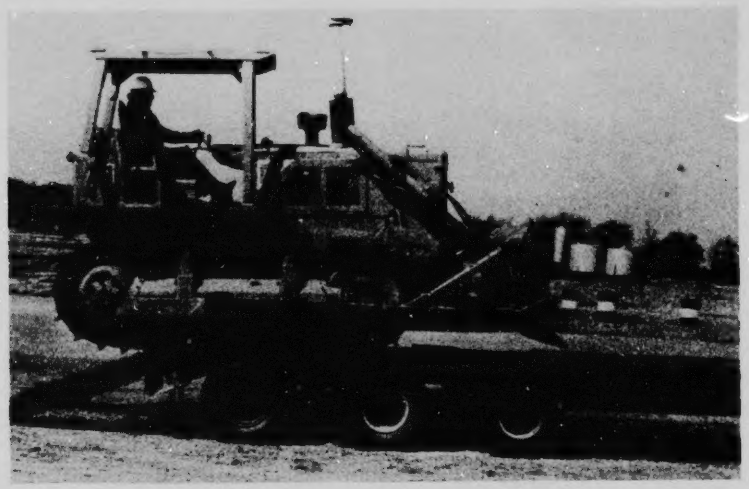
FIGURE 8



JOB SHEET #1

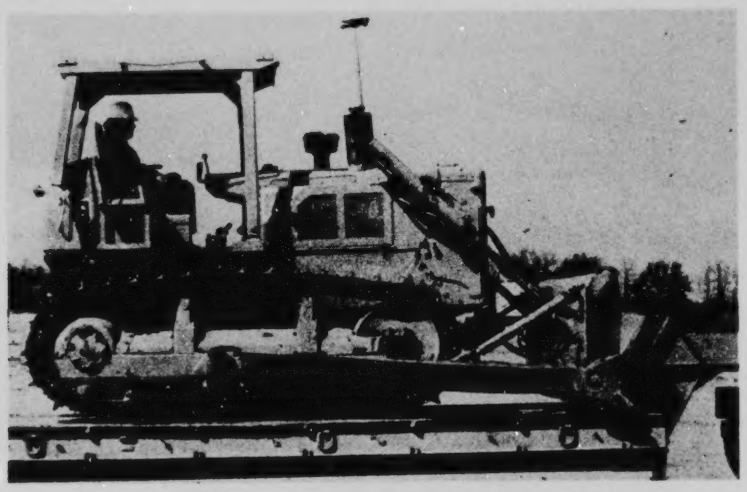
F. Move forward, aligning dozer on trailer (Figure 9)

FIGURE 9



G. Move to front of trailer and correct position for lashing; lower blade to deck and apply brakes (Figure 10)

FIGURE 10



JOB SHEET #1

H. Fasten two chains from drawbar to D-loops toward rear of trailer on each side

I. Fasten a chain to each side of blade and run to D-rings on opposite sides of trailer

J. Set load binders to snug chains; use cheater pipe if needed

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT V

JOB SHEET #2--UNLOAD DOZER FROM REAR

I. Equipment and materials

- A. Dozer
- B. Trailer
- C. Blocks
- D. Chains
- E. Load binders
- F. Ramps

II. Procedure

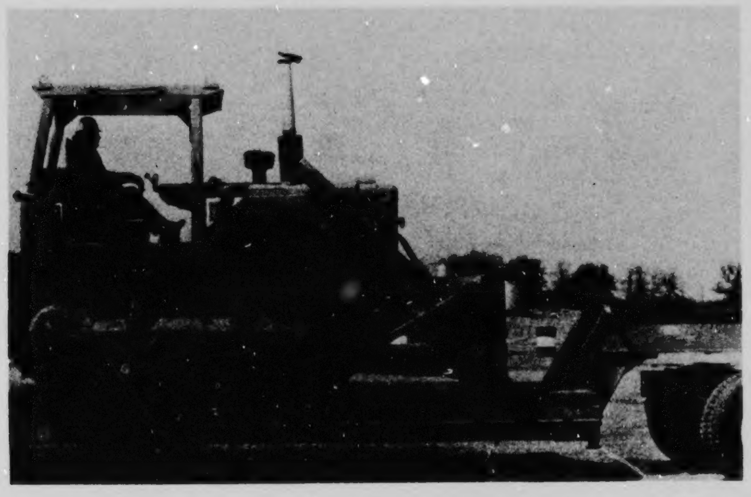
- A. Drop ramps to ground
- B. Remove load binders, chains, and blocks
- C. Start dozer (Figure 11)

FIGURE 11

JOB SHEET #2

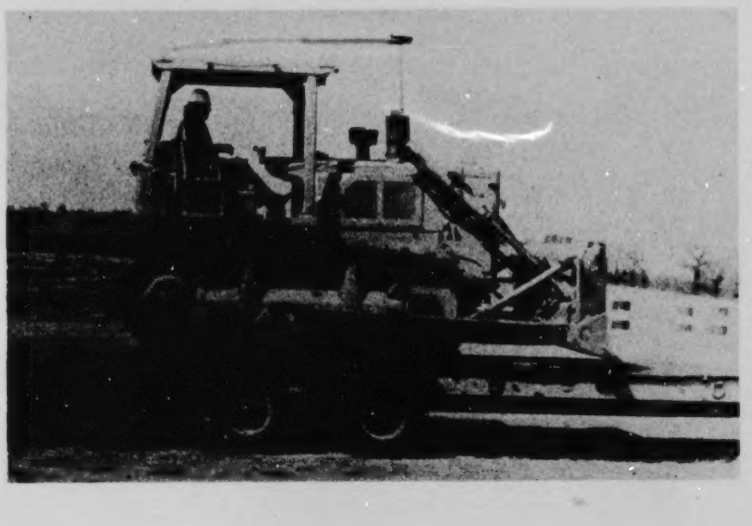
D. Select low gear, raise blade slightly, and start moving backwards (Figure 12)

FIGURE 12



E. Move backwards cautiously, aligning dozer with ramps (Figure 13)

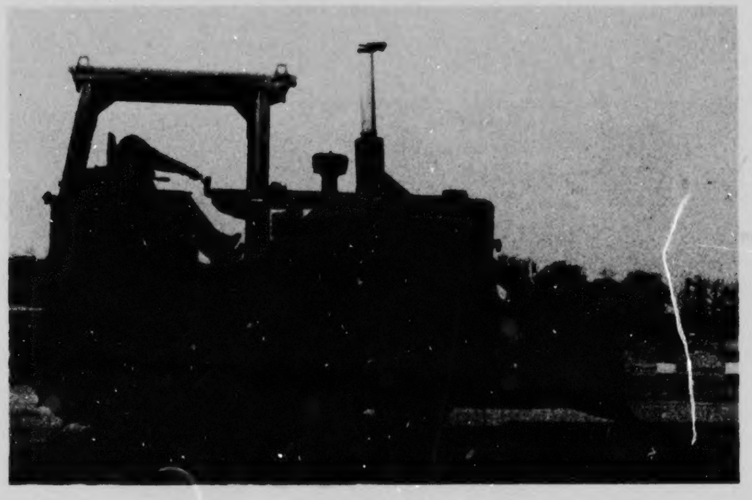
FIGURE 13



JOB SHEET #2

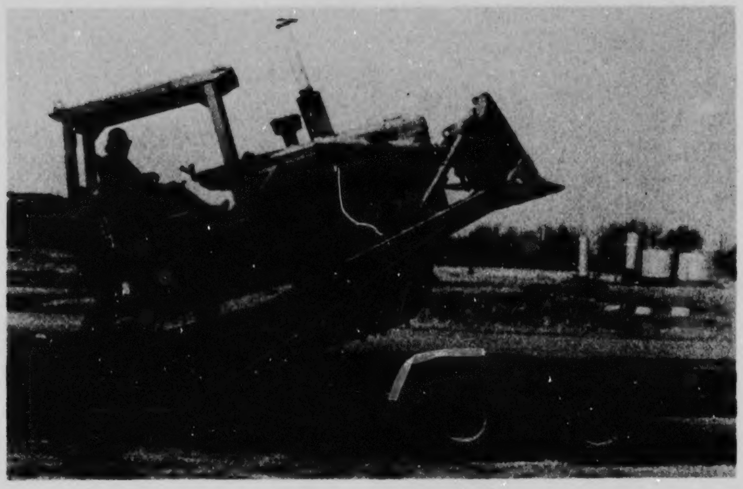
F. Continue backwards to end of trailer (Figure 14)

FIGURE 14



G. Raise blade and move very cautiously over center of gravity (Figure 15)

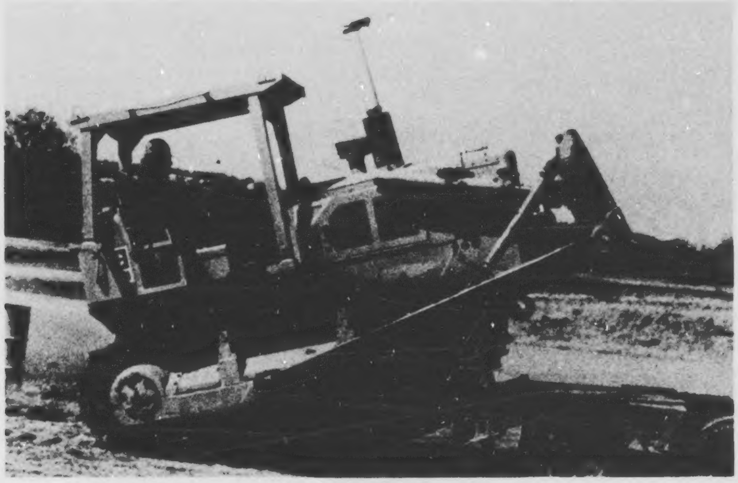
FIGURE 15



JOB SHEET #2

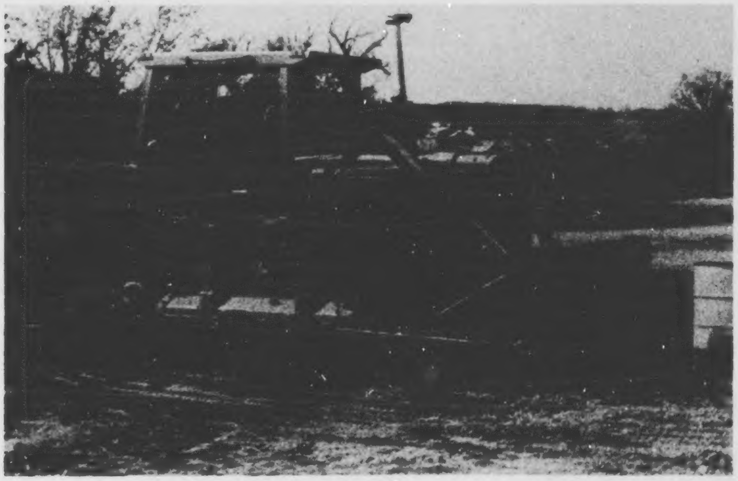
H. Move down ramps to ground (Figure 16)

FIGURE 16



I. Move tractor completely off ramps and away from trailer (Figure 17)

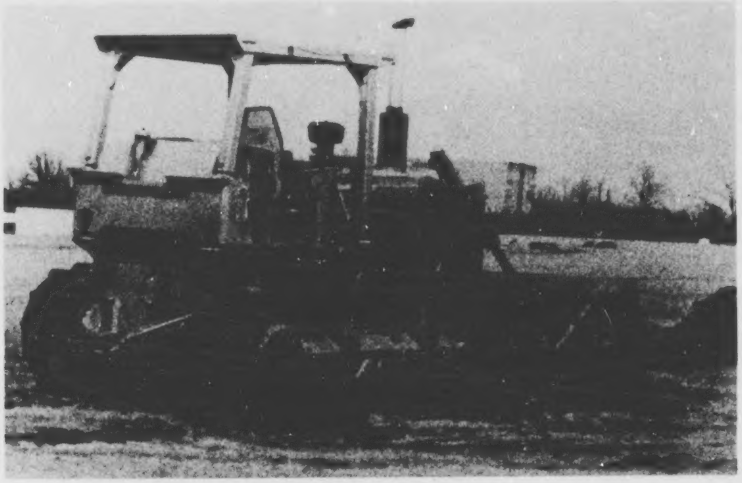
FIGURE 17



JOB SHEET #2

J. Secure dozer and dismount (Figure 18)

FIGURE 18



LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT V

JOB SHEET #3--WINCH A LOAD

I. Equipment, materials, and personnel

   A. Dump truck operator

   B. Transport with winch (tractor and trailer)

   C. Disabled dump truck

   D. Ramps

   E. Blocks

   F. Chains

   G. Load binders

   H. Recommended safety equipment

      1. Hard hat

      2. Gloves

      3. Close-fitting clothes

II. Procedure

   A. Position trailer directly in front of or in back of truck

      (NOTE: If possible, winch truck forward onto trailer.)

   B. Shift transmission to neutral and let engine run

   C. Set parking brake

   D. Block trailer wheels on both sides

   E. Secure ramps in loading position

   F. Engage power takeoff to the winch drum

   G. Move drum clutch lever to "unreel" position

   H. Unreel just enough cable to remove the cable hook from its mooring

   I. Move clutch to neutral position

   J. Remove cable hook from its mooring and set it on the trailer bed near the winch

   K. Move clutch to "unreel" position

JOB SHEET #3

L. Carry cable hook to dump truck

M. Secure cable hook to truck *frame*

(CAUTION: Never attach a winch or tow cable to a bumper, bracket, or brace. Attach to the frame only!)

N. Signal truck operator to release truck brake and set gearshift lever in neutral

O. Move winch drum clutch lever to "reel-in" position

P. Winch truck, guided by the truck operator, onto trailer

Q. Place winch clutch in neutral position when truck is loaded

R. Signal truck operator to set parking brake and get out of truck

S. Lash truck securely

T. Unreel enough cable to remove hook from truck

U. Remove cable from truck frame

V. Secure cable hook in its mooring

W. Reel in cable until it is taut

X. Disengage the power takeoff to the winch drum

Y. Remove blocks from trailer wheels and store them in their proper places

Z. Release transport tractor and trailer brakes

AA. Transport disabled dump truck to repair shop

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT V

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with loading, lashing, and unloading to their correct definitions. Write the correct numbers in the blanks.

   ______a. To line or support with timber framework

   ______b. Ridge or cleat across a track shoe; improves traction

   ______c. Unit consisting of a draw tongue, an axle with wheels, and a turntable platform to support a trailer gooseneck

   ______d. Wooden, triangular shapes to fit track or tires

   ______e. Levers that pull two grab hooks together and hold them by locking over center

   ______f. Point of balance where any additional movement will tip equipment

   ______g. Fixture or bracket which secures winch cable hook to tractor

   ______h. Extended pipe used with load binders for additional leverage

   1. Grouser
   2. Blocks
   3. Cribbing
   4. Load binders
   5. Dolly
   6. Center of gravity
   7. Cheater pipe
   8. Mooring

2. State ten safety precautions for loading and moving equipment.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

   f. ______________________________

   g. ______________________________

   h. ______________________________

   i. ______________________________

   j. ______________________________

TEST

3. List five types of equipment used to move equipment.

a. ____

b. ____

c. ____

d. ____

e. ____

4. Select from the following list devices used to load equipment. Write an "X" in the blank before each correct answer.

_____a. Self loaders

_____b. Steel channel irons

_____c. Wood planks

_____d. Cribbing timbers

_____e. Concrete blocks

_____f. Dirt piles

_____g. Wood reinforced with steel plates or angles

_____h. I-beams

5. State reasons for side loading equipment.

a. ____

b. ____

c. ____

d. ____

6. List five precautions for side loading.

a. ____

b. ____

c. ____

d. ____

e. ____

TEST

7. Discuss why and how pavement should be protected.

   a. Why--____

   ____

   ____

   ____

   b. How--____

   ____

   ____

   ____

8. Select from the following list steps in lashing equipment. Write an "X" in the blank before each correct answer.

   ______a. Place blocks at each end of both tracks or tires

   ______b. Take equipment out of gear and release brakes

   ______c. Leave equipment in gear with clutch engaged and brakes locked

   ______d. Fasten chains from each corner of equipment to the D-loops on the trailer sides; or fasten chain to loop on one side of trailer, then over equipment to loop on other side and tighten

   ______e. Place load binders on side of trailer where they can be seen from rear view mirror

   ______f. Fasten rope to loop on the side of trailer, then over equipment to loop on other side and tighten

   ______g. Wrap end of chain around load binder to prevent binder from vibrating loose

   ______h. Fasten chain completely around equipment

(NOTE: Test question 9 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

9. Demonstrate the ability to

   a. Load dozer from rear.

   b. Unload dozer from rear.

   c. Winch a load.

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT V

ANSWERS TO TEST

1. a. 3
   b. 1
   c. 5
   d. 2
   e. 4
   f. 6
   g. 8
   h. 7
2. Answer should include any ten of the following
   a. Signal before moving
   b. Use crawler blocks and safety chains
   c. Use signal person when clearances are close
   d. Never overload trailer
   e. Know height, width, and weight of load
   f. Use substantial ramp or blocks when loading
   g. Set swing brake and/or lock
   h. Be sure all loose gear, outrigger beams, and pads are secure
   i. Follow manufacturer's instructions when towing
   j. Travel with lights on
   k. Use proper signs and warning flags
   l. Do not exceed bridge load limits
   m. Watch for narrow spots and low clearances
   n. Allow for boom overhang and structure clearances when turning corners
   o. Slow down when crossing obstacles
   p. Watch height clearance when moving boom equipment

ANSWERS TO TEST

q. Tie down or cover rain cap

r. Allow for added length when turning, stopping, or passing

3. Answer should include any five of the following

   a. Girder frame deck trailer with stationary gooseneck

   b. Deck trailer with detachable gooseneck

   c. Extra-heavy trailer with multiple dollies

   d. Girder or I-beam trailer

   e. Low-bed trailer (low-boy)

   f. Tilt-bed trailer

   g. Dump truck

   h. Flatbed truck with tilting rollback bed

4. a, c, d, g

5. a. More convenient in small areas

   b. Shorter and lighter ramps may be used

   c. Drop-deck models are lower at sides

   d. Sometimes only blocks are needed

6. Answer should include any five of the following

   a. Do not lay ramps on edge of deck

   b. Be sure to block trailer before loading

   c. Take special care when loading large equipment from side; turning may be very difficult

   d. Be sure weight is distributed evenly

   e. Do not rest any part of load over exposed tires unless the part is high enough for tires to turn freely

   f. Be sure all machines are blocked and tied down when transporting

   g. Avoid loading in wet, muddy, or icy conditions

ANSWERS TO TEST

7. Discussion should include the following
   a. Why
      1) To prevent scuffing during turns
      2) To prevent crushing of asphalt pavements
      3) To prevent bruising of pavements
      4) To prevent digging in of grousers
   b. How--Cover with
      1) Planking
      2) Layer of dirt
      3) Cribbing
      4) Mats
      5) Rubber tires
8. a, c, d, e, g
9. Performance skills evaluated to the satisfaction of the instructor

PRINCIPLES OF ENGINE OPERATION
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to distinguish the basic differences between diesel and gasoline engines. The student should also be able to identify components of basic engines and state their purposes. This knowledge will be shown by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to

1. Match terms associated with principles of engine operation to their correct definitions.
2. Label basic parts of diesel and gasoline engines.
3. Arrange in order the strokes in a two-stroke or four-stroke engine.
4. List basic differences between a gasoline engine and a diesel engine.
5. Identify components of a cooling system.
6. Match types of cooling systems to their correct uses.
7. Select from a list requirements of a good coolant.
8. Describe operation of thermostat when engine is cold and when engine is at operating temperature.
9. Distinguish between components of fuel systems for gasoline and diesel engines.
10. Distinguish between functions of gasoline and diesel engine fuel systems.
11. Distinguish among types of air cleaners.
12. Distinguish between direct current and alternating current.
13. State functions of a battery.
14. Select from a list processes by which a battery converts chemical energy into electrical energy.
15. Select from a list safety rules pertaining to care and maintenance of batteries.
16. Label components of the starting system.

OBJECTIVE SHEET

17. Match major parts of a starting circuit to their correct functions.

18. List components of the ignition system.

19. Arrange in order steps in operation of ignition system through one cycle.

20. Label major components of an electronic ignition system.

21. Match major components of an electronic ignition system to their correct functions.

22. State purposes of engine lubrication system.

23. Select from a list characteristics of good engine oil.

24. List oil contaminants.

25. Match oil additives to their correct functions.

26. State general rules for selecting engine oil.

27. Demonstrate the ability to

    a. Test antifreeze solution.

    b. Service an air cleaner.

    c. Clean and service a battery.

    d. Remove and replace a battery.

    e. Measure battery electrolyte with a hydrometer.

    f. Start an engine using a negative-ground booster battery.

    g. Use a 24-volt battery booster system to start a vehicle with a 12-volt system.

    h. Remove and replace contact points and condenser.

    i. Remove, service, and replace spark plugs.

    j. Change oil in an engine.

    k. Change an oil filter.

PRINCIPLES OF ENGINE OPERATION
UNIT VI

SUGGESTED ACTIVITIES

I. Suggested activities

   A. Order materials planned to supplement unit.

      (NOTE: Engine manufacturers are excellent sources for slide and film presentations on gasoline and diesel engines. Write directly to the appropriate company or manufacturer.)

   B. Make transparencies.

   C. Provide students with objective sheet.

   D. Provide students with information and job sheets.

   E. Discuss unit and specific objectives.

   F. Discuss information sheet.

   G. Demonstrate and discuss procedures outlined in job sheets.

   H. Check with major engine manufacturers for visual aids to demonstrate basic engine operation.

   I. Give test.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM #1--Two-Stroke Cycle Operation (Gasoline and Diesel)
      2. TM #2--Four-Stroke Cycle Operation (Gasoline)
      3. TM #3--Four-Stroke Cycle Operation (Diesel)
      4. TM #4--Cooling System Components (Gasoline)
      5. TM #5--Cooling System Components (Diesel)
      6. TM #6--Thermostat Operation
      7. TM #7--Fuel System Components (Gasoline)
      8. TM #8--Fuel System Components (Diesel)

SUGGESTED ACTIVITIES

   9. TM #9--Types of Air Cleaners
   10. TM #10--Types of Air Cleaners (Continued)
   11. TM #11--Current and Electrolyte
   12. TM #12--Components of the Starting System
   13. TM #13--Major Components of the Ignition System
   14. TM #14--Operation of the Ignition System
   15. TM #15--Operation of the Ignition System (Continued)
   16. TM #16--Operation of the Ignition System (Continued)
   17. TM #17--Operation of the Ignition System (Continued)
   18. TM #18--Operation of the Ignition System (Continued)
   19. TM #19--Major Components of the Electronic Ignition System

E. Job sheets

   1. Job Sheet #1--Test Antifreeze Solution
   2. Job Sheet #2--Service an Air Cleaner
   3. Job Sheet #3--Clean and Service a Battery
   4. Job Sheet #4--Remove and Replace a Battery
   5. Job Sheet #5--Measure Battery Electrolyte with a Hydrometer
   6. Job Sheet #6--Start an Engine Using a Negative-Ground Booster Battery
   7. Job Sheet #7--Use a 24-Volt Battery Booster System to Start a Vehicle with a 12-Volt System
   8. Job Sheet #8--Remove and Replace Contact Points and Condenser
   9. Job Sheet #9--Remove, Service, and Replace Spark Plugs
   10. Job Sheet #10--Change Oil in an Engine
   11. Job Sheet #11--Change an Oil Filter

F. Test

G. Answers to test

SUGGESTED ACTIVITIES

III. Unit references

A. Armstrong, Ivan J. *Auto Mechanics: Volume I.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1976.

B. Armstrong, Ivan J. *Auto Mechanics: Volume II.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1978.

C. Armstrong, Ivan J., and Bundy, Mike. *Specialized Units in Auto Mechanics.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1979.

D. Foutes, William A. *Diesel Engine Mechanics.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc., 1977.

E. Hendrix, Laborn J. "Bud." *Heavy Equipment Operator: Volume I.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1981.

PRINCIPLES OF ENGINE OPERATION
UNIT VI

INFORMATION SHEET

I. Terms and definitions

- A. Compression--Reduction in volume of gases trapped in cylinder by upward motion of piston
- B. Cycle--Series of events that repeats itself in a regular sequence
- C. TDC--Top dead center
- D. BDC--Bottom dead center
- E. Stroke--Distance piston moves when traveling from TDC to BDC
- F. Compression ratio--Ratio of whole cylinder volume to clearance volume

  EXAMPLE: If cylinder volume at TDC is at 45 cubic inches and clearance volume is 5 cubic inches, the compression ratio is

  45 ÷ 5 = 9 or 9:1 ratio

- G. Volume--Total space between piston at BDC and cylinder head
- H. Clearance volume--Total space between piston at TDC and cylinder head
- I. Coolant--Liquid that circulates through cooling system to transfer engine heat
- J. Antifreeze--Substance added to cooling system to lower its freezing point
- K. Thermostat--Heat-controlled valve in the cooling system used to regulate the flow of coolant between cylinder block and radiator
- L. Pressure cap--Radiator cap which increases pressure within cooling system several psi, allowing coolant to circulate at higher temperatures without evaporation or surge loss
- M. psi--Pounds per square inch
- N. Atomize--To reduce a liquid to a fine spray
- O. Injection nozzle--Device that atomizes fuel and sprays it into combustion chamber

INFORMATION SHEET

P. Dwell--Number of degrees of distributor cam rotation that ignition points are closed

Q. Viscosity--Measure of ability of an oil to resist flowing

R. SAE--Abbreviation for Society of Automotive Engineers; classification of motor, transmission, or differential lubricants to indicate viscosities standardized by this society

S. Eccentric--Disc or offset section (of a shaft) used to convert rotary motion to reciprocating motion (cam)

T. Voltage--Potential difference or electromotive force measured in volts

U. Current--Flow of electric charge

V. Resistance--Property of a conductor by which it opposes the flow of an electric current and generates heat in conducting material

W. Conductor--Wire, cable, or other medium suitable for carrying electric current

X. Newton--The unit of force in the mks (meter-kilogram-second) system

Y. Ampere--Standard unit for measuring the strength of an electric current; rate of flow or charge in a conducting medium

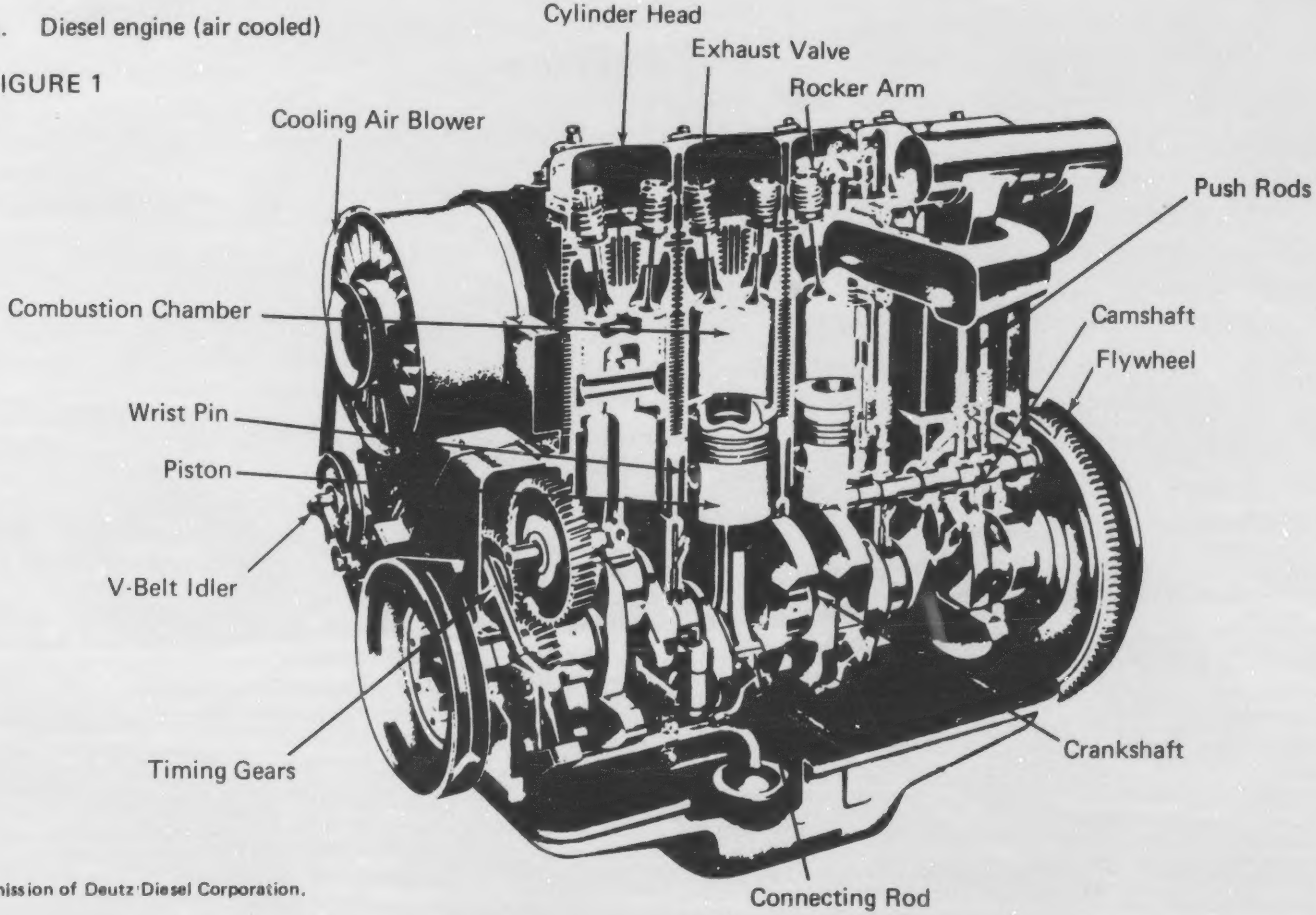
Z. Scavenge--Method of pushing air out of cylinders during the exhaust stroke on two-cycle engines

INFORMATION SHEET

II. Basic parts of diesel and gasoline engines (Figures 1 and 2)

A. Diesel engine (air cooled)

FIGURE 1

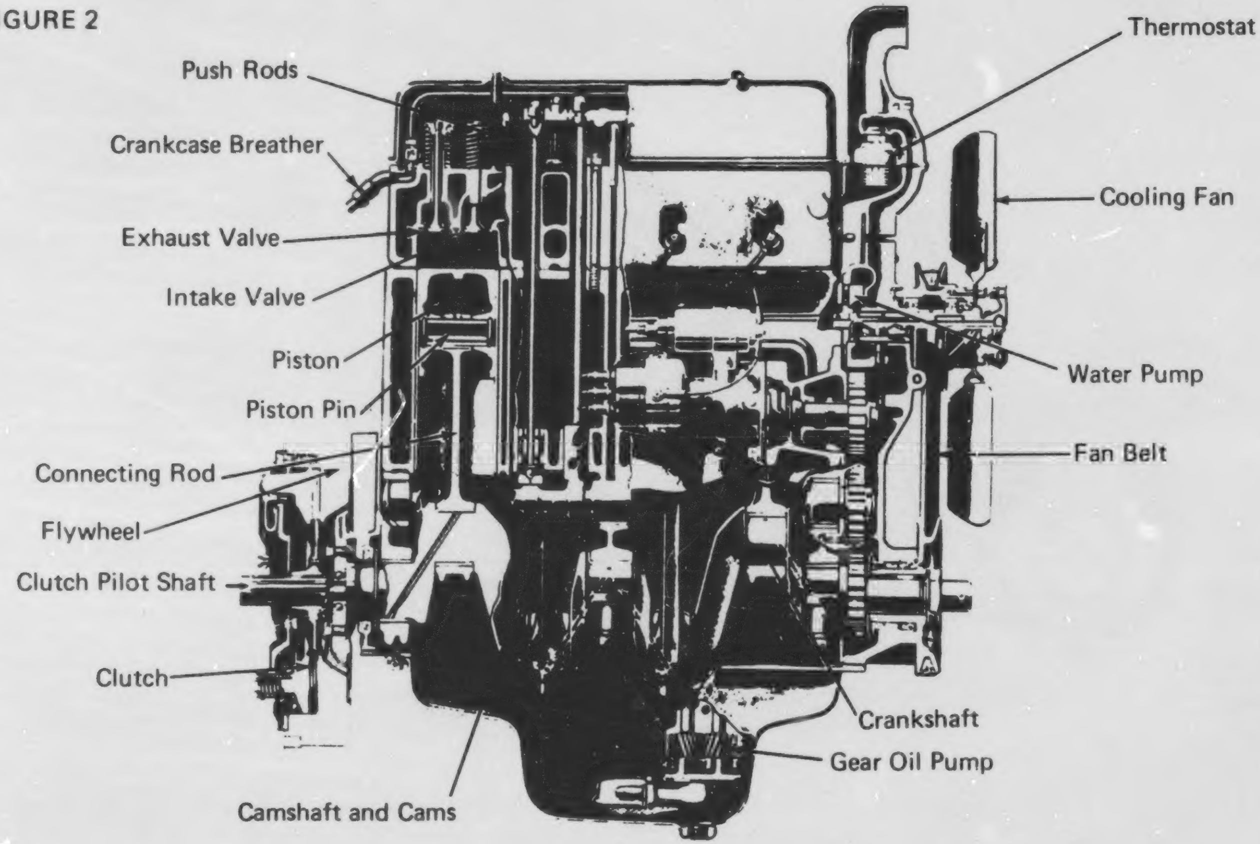

Cylinder Head
Exhaust Valve
Rocker Arm
Cooling Air Blower
Push Rods
Combustion Chamber
Camshaft
Flywheel
Wrist Pin
Piston
V-Belt Idler
Timing Gears
Crankshaft
Connecting Rod

Used with permission of Deutz Diesel Corporation.

INFORMATION SHEET

B. Gasoline engine (industrial)

FIGURE 2


Push Rods
Crankcase Breather
Exhaust Valve
Intake Valve
Piston
Piston Pin
Connecting Rod
Flywheel
Clutch Pilot Shaft
Clutch
Camshaft and Cams
Thermostat
Cooling Fan
Water Pump
Fan Belt
Crankshaft
Gear Oil Pump

Used with permission of International Harvester Company.

INFORMATION SHEET

III. Order of strokes in a two-stroke or four-stroke engine (Transparencies #1, #2, and #3)

(NOTE: Two-stroke and four-stroke refer to the number of times the piston travels up and down in the cylinder to complete one cycle of operation.)

A. Intake

B. Compression

C. Power (ignition)

D. Exhaust

IV. Basic differences between gasoline and diesel engines

A. Gasoline

1. Ignition by electrical spark

2. Takes fresh air and fuel through carburetor, and then to combustion chamber

3. Low compression ratio (7-12:1)

4. Burns gasoline

B. Diesel

1. Ignition by compression

2. Takes fresh air directly to combustion chamber

3. High compression ratio (16-22:1)

4. Burns low-grade fuel oil

V. Components of a cooling system (Transparencies #4 and #5)

(NOTE: The purpose of the cooling system is to keep the engine at its most efficient operating temperature during all engine speeds and driving conditions.)

A. Radiator

B. Radiator hose

C. Water pump

D. Thermostat

INFORMATION SHEET

   E. Engine water jacket
   F. Pressure cap
   G. Fan (reversible in diesel system)
   H. Fan belt
   I. Bypass
   J. Coolant
   K. Air flow
   L. Shutters (diesel engine)

VI. Types of cooling systems and their uses

   A. Liquid--Uses circulating coolant
   B. Air--Uses a fan

VII. Requirements of a good coolant (Job Sheet #1)

   A. Prevents freezing (water coolant only)
   B. Inhibits rust and corrosion
   C. Chemically stable
   D. Nonconductor of electricity
   E. Flows readily at all temperatures
   F. Conducts heat readily
   G. Resists foaming
   H. Provides lubrication for water pump seal

VIII. Operation of thermostat (Transparency #6)

   A. When engine is cold--Thermostat shuts off flow of coolant from engine to radiator to allow quicker engine warm-up
   B. When engine is at operating temperature--Thermostat is open and allows coolant to circulate through system

INFORMATION SHEET

IX. Components of fuel systems for gasoline and diesel engines (Transparencies #7 and #8)

   A. Fuel tank

   B. Fuel filter

   C. Fuel pump (gasoline engine) or fuel transfer pump (diesel engine)

   D. Carburetor (gasoline engine)

   E. Air cleaner (gasoline engine)

   F. Injection pump (distributor type) (diesel engine)

   G. Injection nozzles (diesel engine)

   H. Fuel lines

X. Functions of gasoline and diesel engine fuel systems

   A. Gasoline--Pumps fuel from tank through filters into carburetor where it is mixed with air in proper proportion for a combustible mixture and then is delivered to cylinders

   B. Diesel--Pumps fuel at low pressure from tank through filters to injection pump where it times the fuel delivery, and measures and delivers fuel under pressure to injection nozzle, where it is atomized and sprayed into combustion chamber

XI. Types of air cleaners (Transparencies #9 and #10; Job Sheet #2)

   A. Dry element--Cleans by passing air through a treated paper filter

   B. Viscous impingement--Cleans by passing air through a maze of metal wool, wire, or screens saturated with oil

   C. Oil bath--Cleans by directing air through a center tube into inner oil cup where direction of air flow is reversed, causing most dirt to become trapped by the oil and settle in the sump

XII. Direct current and alternating current

   A. Direct current (DC)

      1. Supplied by generator and battery (dry and wet cell)

      2. Flows in one direction only

   B. Alternating current (AC)

      1. Supplied by alternating current generator (alternator)

      2. Flows in one direction; then reverses and flows in the opposite direction

INFORMATION SHEET

XIII. Functions of a battery

- A. Supplies current for cranking engine
- B. Supplies current when demand exceeds output of charging system
- C. Stabilizes voltage in system during operation

XIV. Processes by which a battery converts chemical energy into electrical energy (Transparency #11)

- A. Two dissimilar metals placed in acid solution will produce chemical action
- B. More active metal will lose electrons and become positively charged
- C. Less active metal will accumulate electrons and become negatively charged

XV. Safety rules pertaining to care and maintenance of batteries (Job Sheets #3-#7)

- A. Wear safety glasses, rubber gloves, and rubber apron when servicing batteries
- B. Do not allow electrolyte to come in contact with eyes, skin, clothing, or painted surfaces
- C. Flush immediately with water any area of skin which acid has contacted
- D. Avoid breathing fumes from battery
- E. Keep flames or sparks away from battery because gases given off by battery are very explosive

  (NOTE: These gases are hydrogen and oxygen.)
- F. Avoid shorting or grounding battery terminals during service

XVI. Components of the starting system (Transparency #12)

(NOTE: To crank the engine, the starting system converts electrical energy from battery into mechanical energy.)

- A. Battery
- B. Key switch
- C. Starter switch
- D. Starter
- E. Small-gauge switch wire
- F. Battery cable
- G. Solenoid

INFORMATION SHEET

XVII. Functions of major parts of a starting circuit

- A. Battery--Supplies energy for the circuit
- B. Starter switch--Activates the circuit
- C. Motor switch--Closes circuit to motor and engages motor drive with flywheel
- D. Starting motor--Drives flywheel to start engine

XVIII. Components of the ignition system (Transparency #13; Job Sheets #8 and #9)

(NOTE: Ignition system provides a high spark to ignite fuel-air mixture in the combustion chamber.)

- A. Battery
- B. Ignition switch
- C. Primary resistance unit
- D. Ignition coil
- E. Contact points (breaker points)
- F. Condenser
- G. Distributor
- H. Breaker cam
- I. Spark advance mechanism

  (NOTE: There are two types of spark advance mechanisms: vacuum and mechanical. Engine vacuum controls timing advance in relation to engine load. Mechanical advance changes engine timing according to engine speed.)

- J. Rotor
- K. Distributor cap
- L. Spark plug
- M. Primary ignition wire
- N. Secondary ignition wire (high-voltage cable)

INFORMATION SHEET

XIX. Steps in operation of the ignition system through one cycle (Transparencies #14-#18)

A. With the ignition switch on and the contact points closed, low-voltage current flows from the battery through the primary winding of the coil and through the contact points to ground (Transparency #14)

B. The flow of low-voltage current through the primary windings of the coil causes a magnetic field buildup (Transparency #15)

C. As the contact points open, current continues to flow across the point surfaces; the condenser attached to the points absorbs this flow of current (Transparency #16)

D. Stopping this flow of current causes the magnetic field of the coil primary windings to collapse across the secondary coil windings, causing a high-voltage surge (Transparency #17)

E. This high-voltage surge is directed from the secondary windings of the coil through the distributor cap and rotor and on to the spark plug to ground (Transparency #18)

XX. Major components of an electronic ignition system (Transparency #19)

A. Dual ballast resistor

(NOTE: This component is not used in all models.)

B. Control unit

C. Magnetic pickup assembly

D. Armature or reluctor

E. Distributor

F. Ignition coil

G. Distributor housing

XXI. Function of major components of an electronic ignition system

A. Dual ballast resistor--Maintains constant primary current with variations in engine speed

(NOTE: Dual ballast resistor is bypassed during engine starting.)

B. Magnetic pickup assembly--Sends a small voltage pulse to control unit; this triggers switching transistor to stop current flow in the coil primary windings

INFORMATION SHEET

C. Armature or reluctor--Rotates with the distributor shaft, producing a voltage pulse in the magnetic pickup

(NOTE: The armature contains the same number of tips as the engine contains cylinders.)

D. Control unit--Controls the flow of current in the primary windings of the ignition coil and maintains constant dwell

XXII. Purposes of engine lubrication system (Job Sheets #10 and #11)

A. Lubricates moving parts to minimize friction

B. Acts as cooling agent to remove heat from moving parts

C. Forms a seal between piston rings and cylinder walls

D. Keeps parts clean

E. Absorbs shock between bearings and other parts

XXIII. Characteristics of good engine oil (Job Sheet #10)

A. Keeps a protective film on moving parts

B. Resists breakdown at high temperatures

C. Resists corrosion and rusting

D. Prevents carbon buildup

E. Prevents sludge formation

F. Flows easily at low temperatures

G. Resists foaming

H. Resists breakdown after long use

XXIV. Oil contaminants

A. Foreign particles

B. Water

C. Antifreeze

D. Fuel

E. Oxidation

INFORMATION SHEET

XXV. Oil additives and their functions

(NOTE: Most oils already have these additives.)

A. Anti-corrosion additive--Helps prevent failure of alloy bearings from corrosive acids caused by combustion

B. Oxidation inhibitor--Prevents acid, varnish, and sludge formation

(NOTE: Oxidation causes oil to thicken.)

C. Anti-rust additive--Prevents rusting of metal parts during storage or downtime

D. Viscosity index improver--Helps oil give top lubricating protection at both high and low temperatures

E. Pour point depressant--Prevents wax crystals from congealing in cold weather and forming clumps

F. Detergent dispersant--Helps keep metal surfaces clean, and prevents deposit formation

G. Foam inhibitor--Helps prevent air bubbles which would reduce lubrication

(NOTE: Fast circulation causes oil to foam.)

XXVI. General rules for selecting engine oil (Job Sheet #10)

A. Use brands of proper service rating recommended by manufacturer

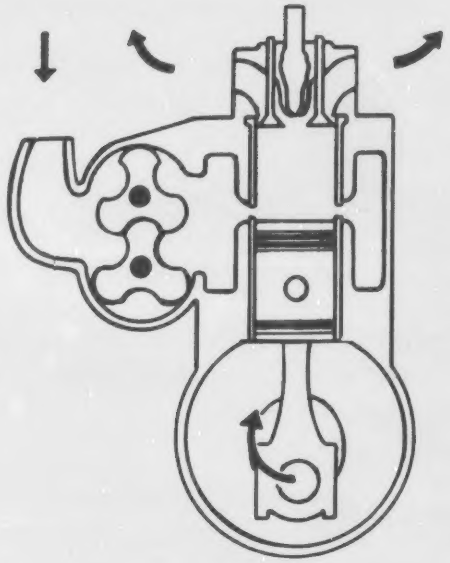
B. Select brands that have been service tested

C. Never mix oils with different SAE or viscosity ratings

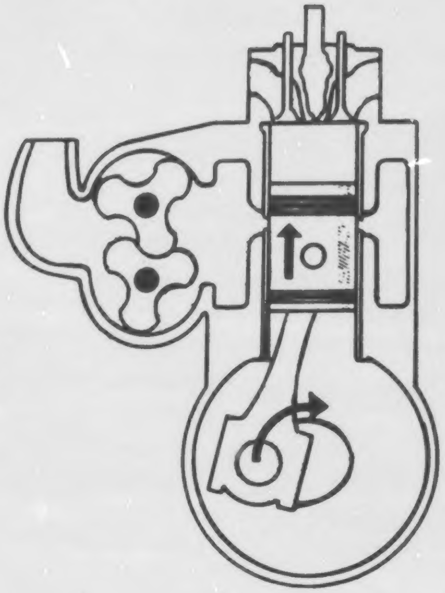
D. Use oil of proper viscosity for average temperature at which the vehicle will operate

DOT I - 469

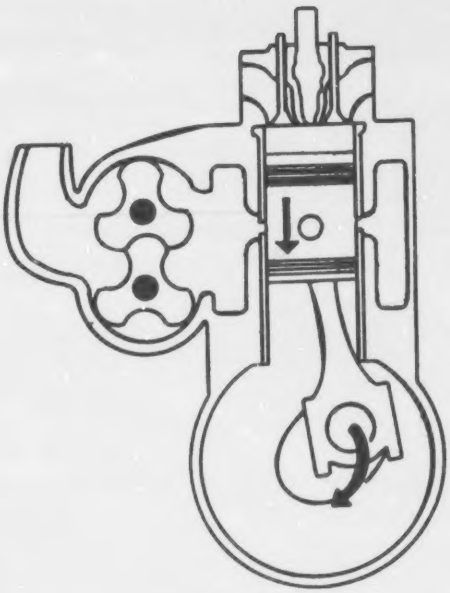
Two-Stroke Cycle Operation (Gasoline and Diesel)



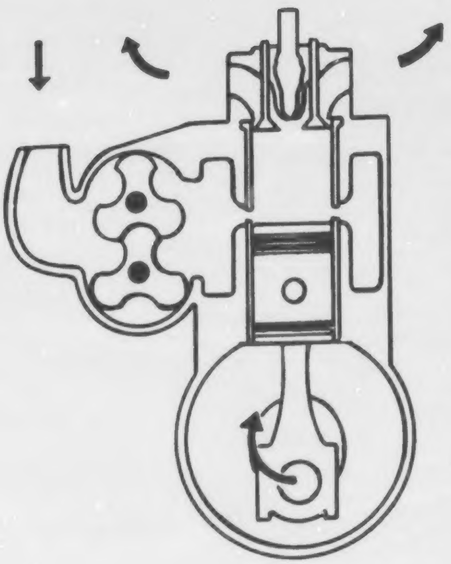
Intake



Compression



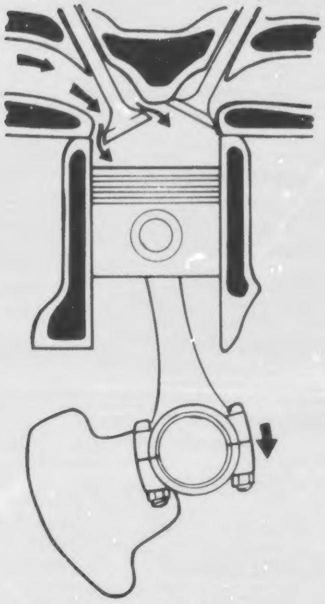
Power



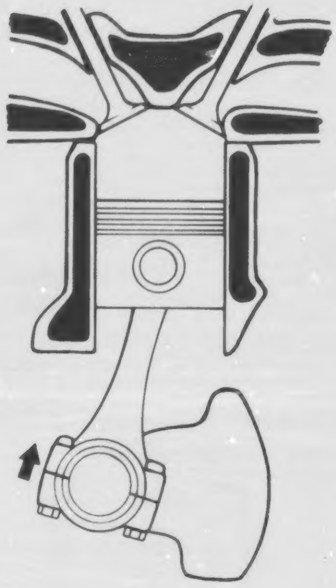
Exhaust

TM #1

Four-Stroke Cycle Operation
(Gasoline)



Intake



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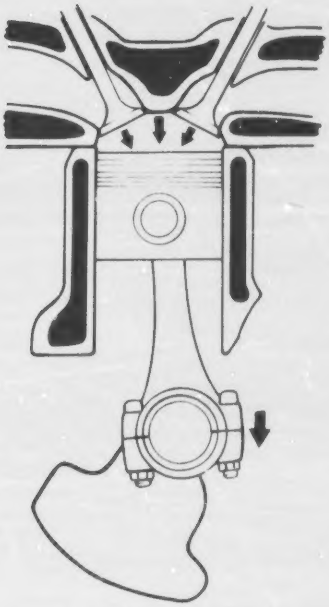
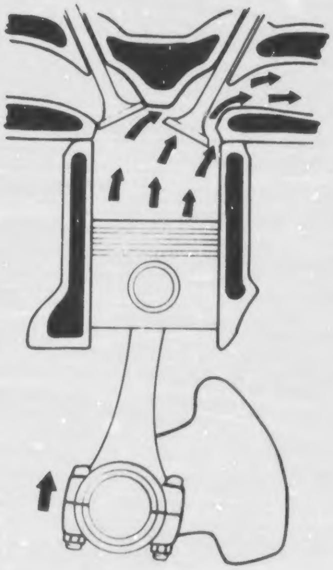
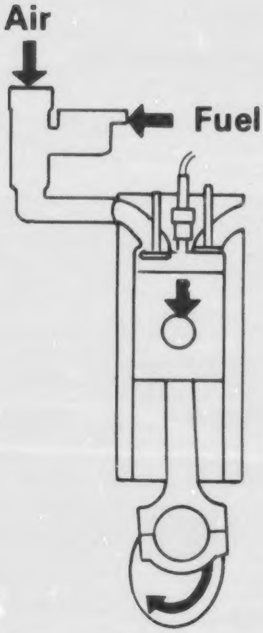


Power

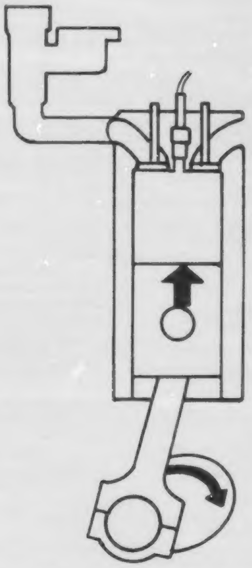


Exhaust

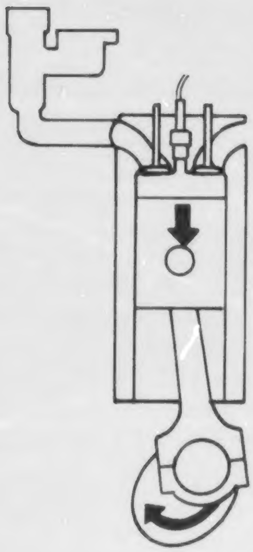
Four-Stroke Cycle Operation (Diesel)



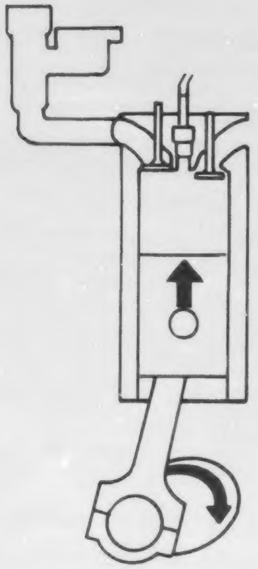
Intake



Compression

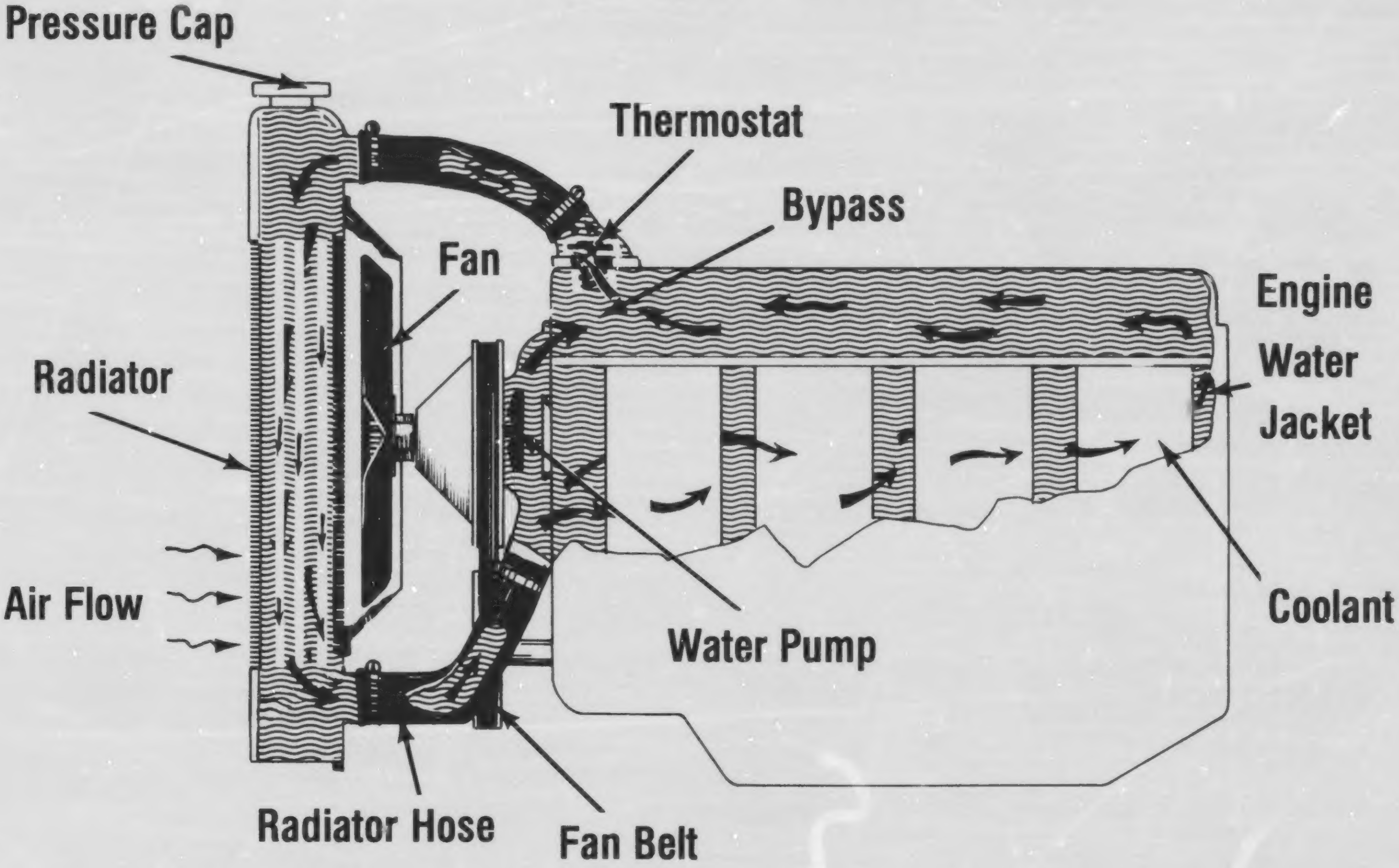


Power

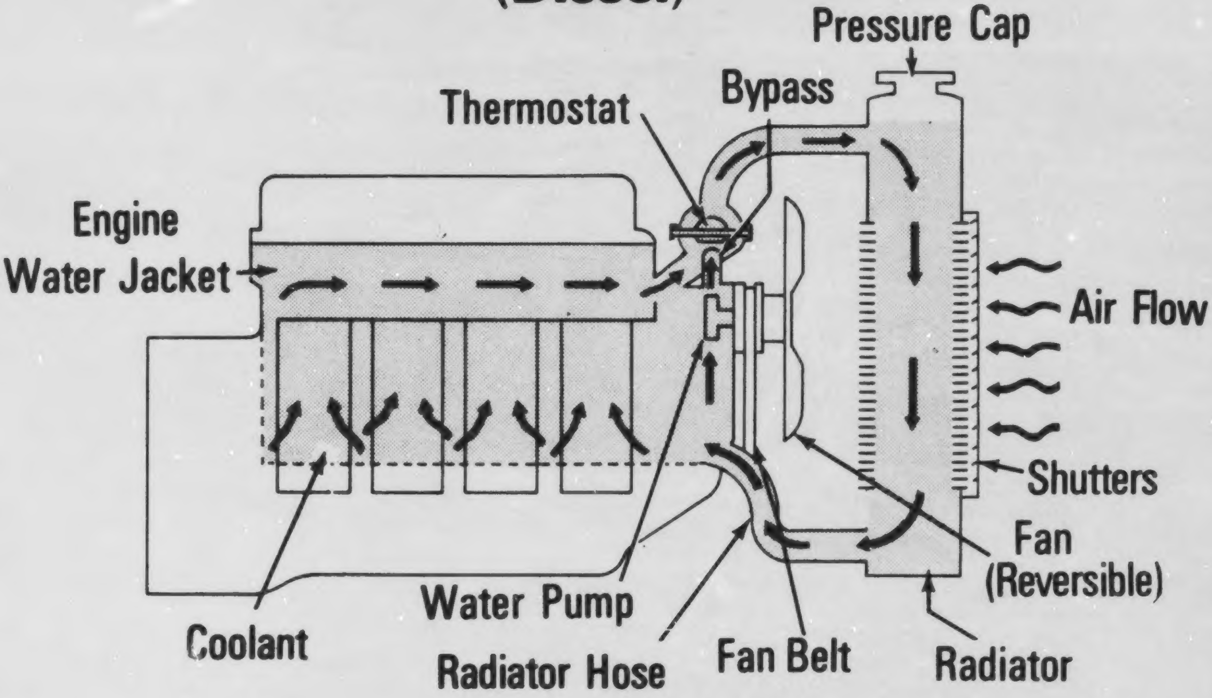


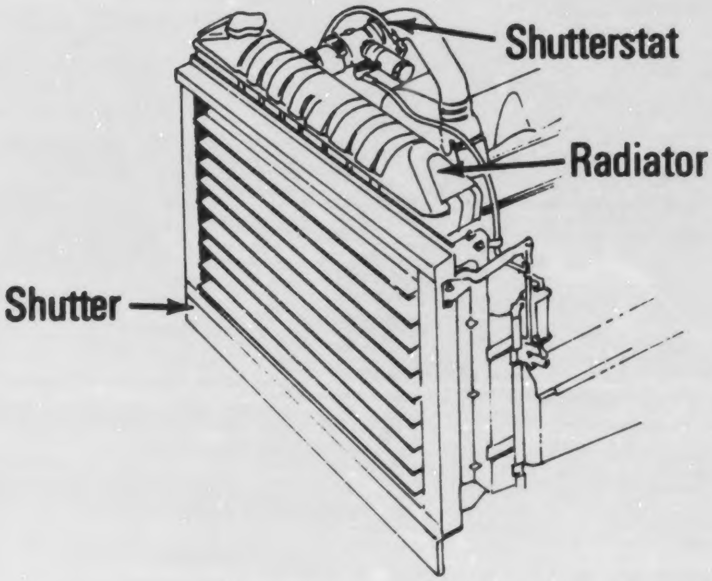
Exhaust

Cooling System Components
(Gasoline)


Pressure Cap
Thermostat
Bypass
Fan
Engine
Water
Jacket
Radiator
Air Flow
Water Pump
Coolant
Radiator Hose
Fan Belt

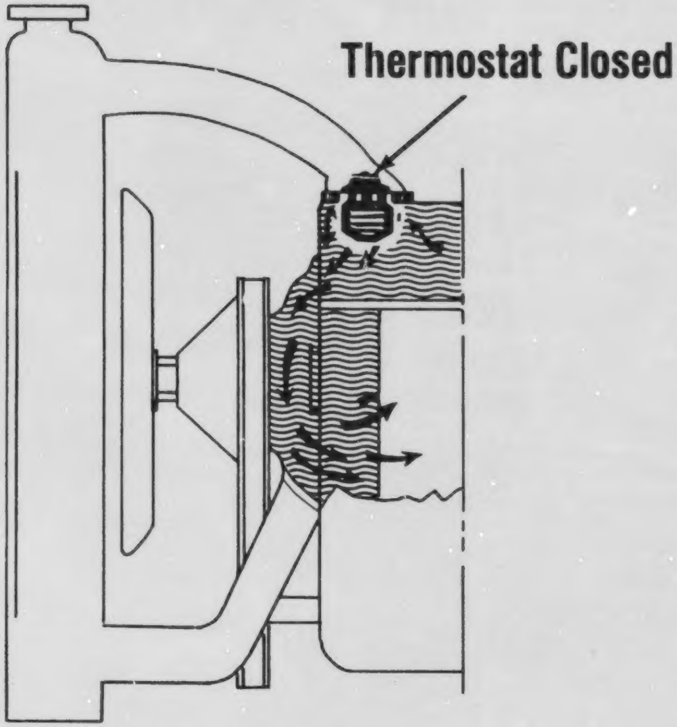
Cooling System Components (Diesel)


Pressure Cap
Bypass
Thermostat
Engine Water Jacket
Air Flow
Shutters
Fan (Reversible)
Coolant
Water Pump
Radiator Hose
Fan Belt
Radiator

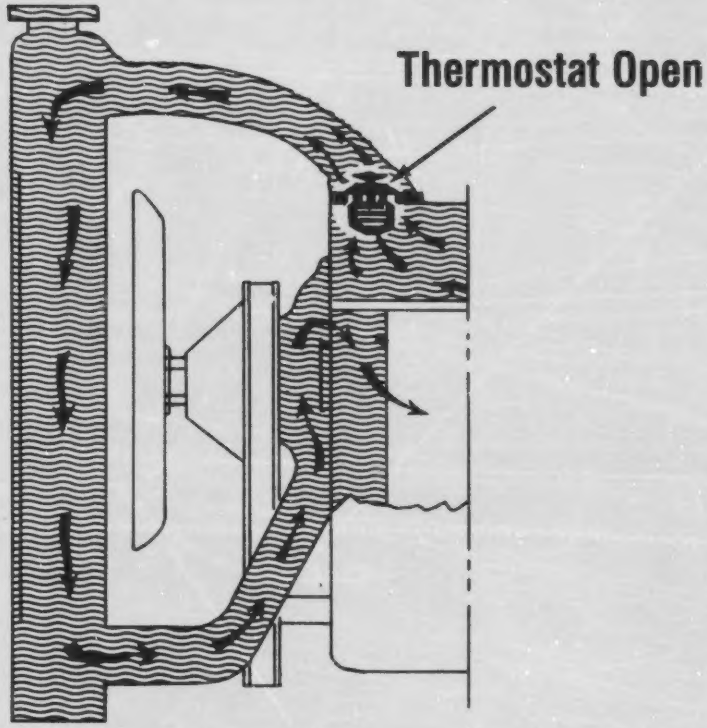

Shutterstat
Radiator
Shutter

Typical Air-Operated Shutter Assembly

Thermostat Operation


Thermostat Closed

Engine Cold

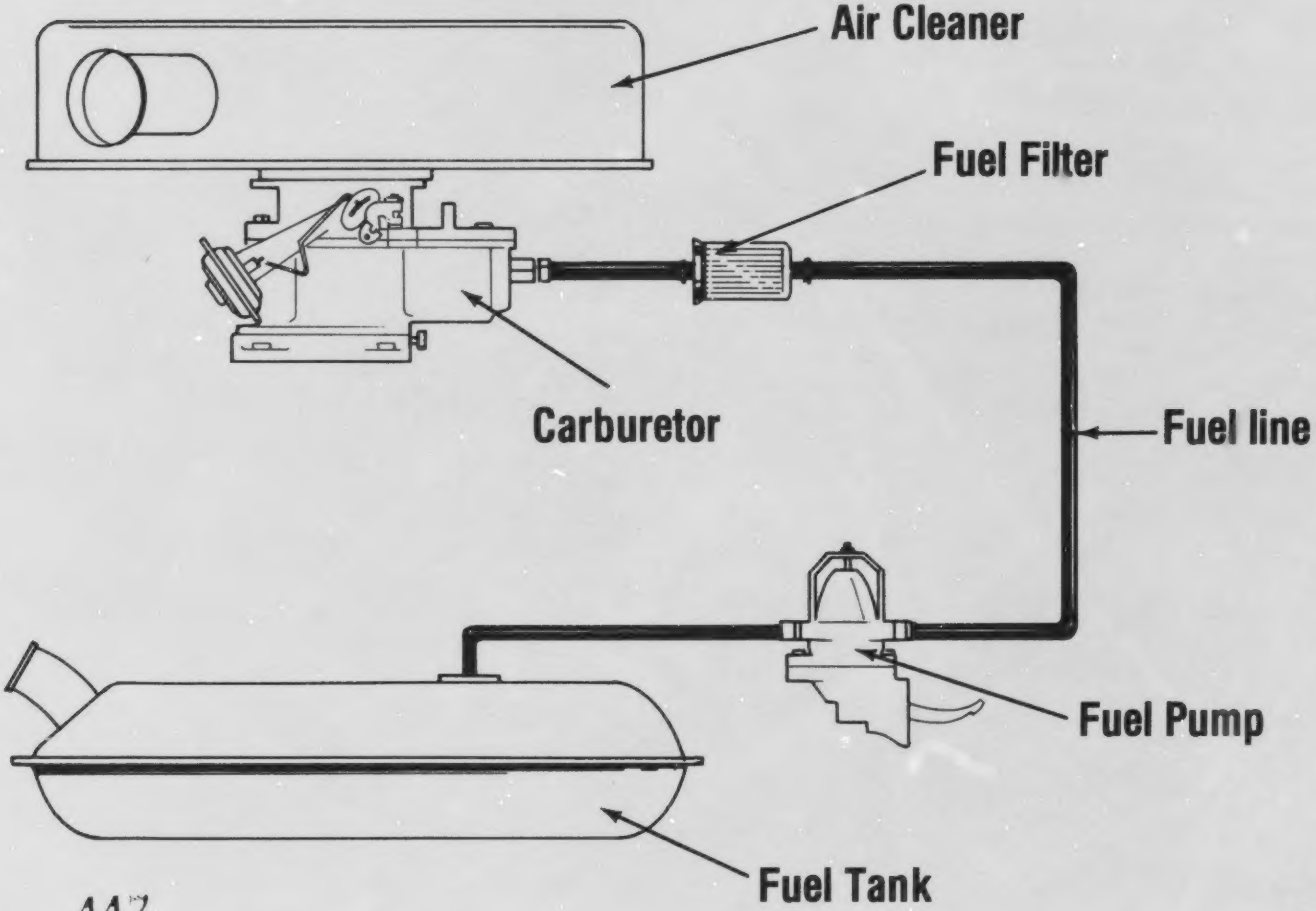

Thermostat Open

Engine at Operating Temperature

TM #6

DOT I-479

Fuel System Components (Gasoline)



Air Cleaner

Fuel Filter

Carburetor

Fuel line

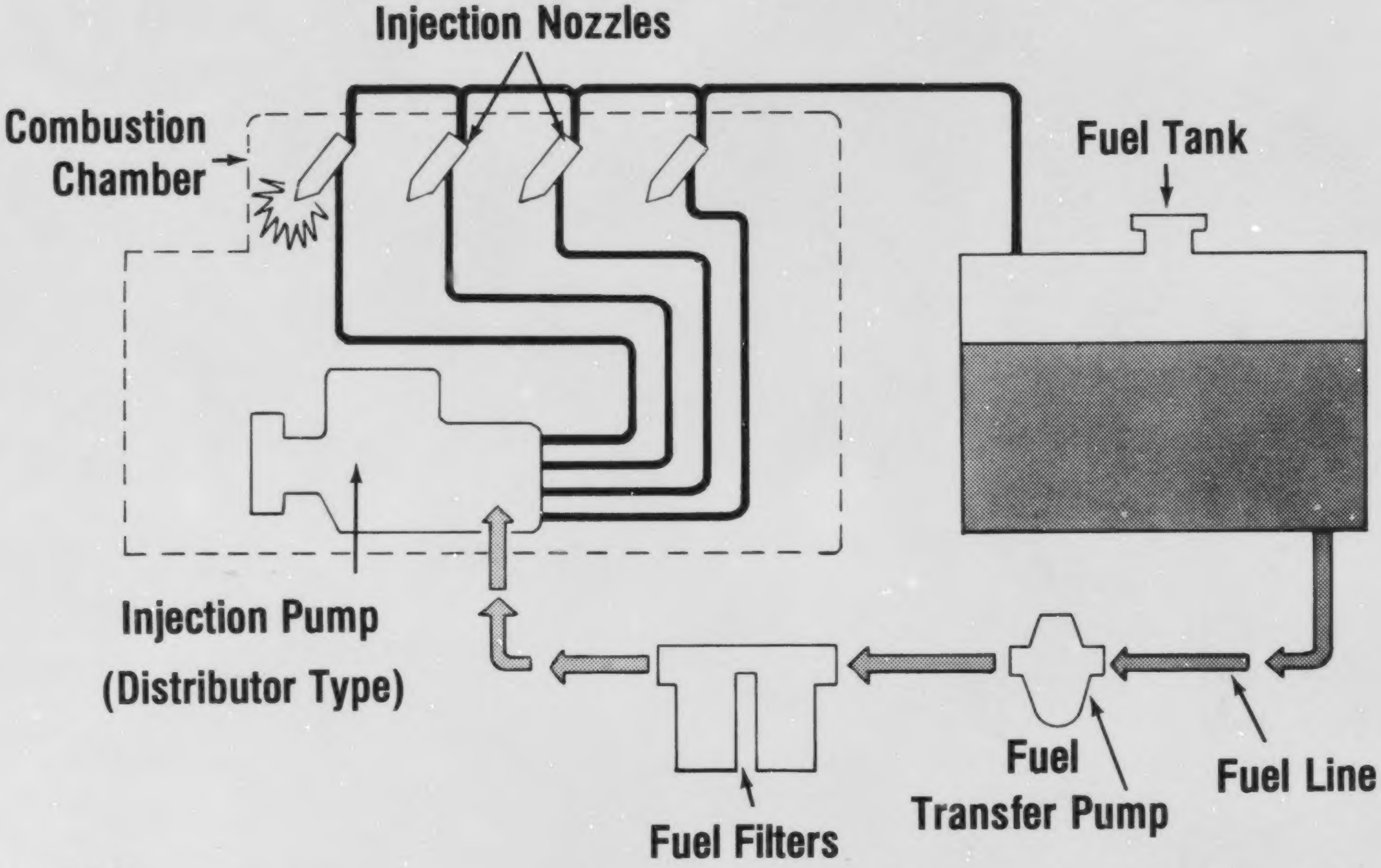
Fuel Pump

Fuel Tank

TM #7

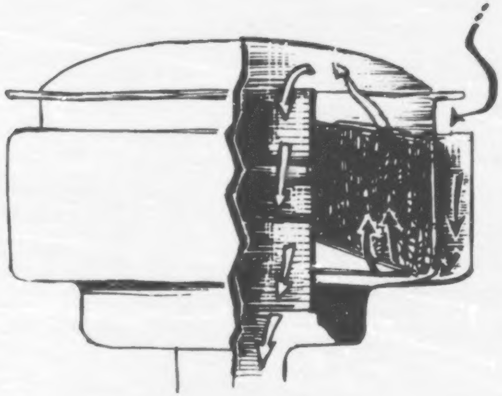
DOT I - 481

Fuel System Components (Diesel)

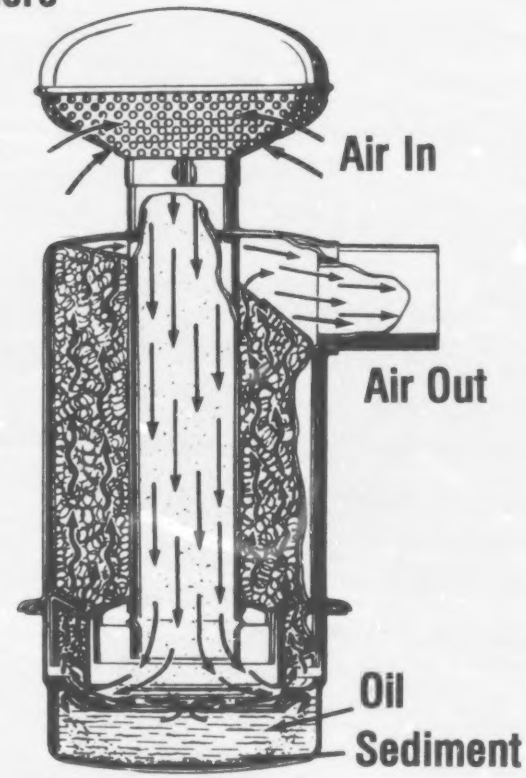

Injection Nozzles
Combustion Chamber
Fuel Tank
Injection Pump
(Distributor Type)
Fuel Filters
Fuel Transfer Pump
Fuel Line

Types of Air Cleaners

Oil Bath Air Cleaners



Oil Bath

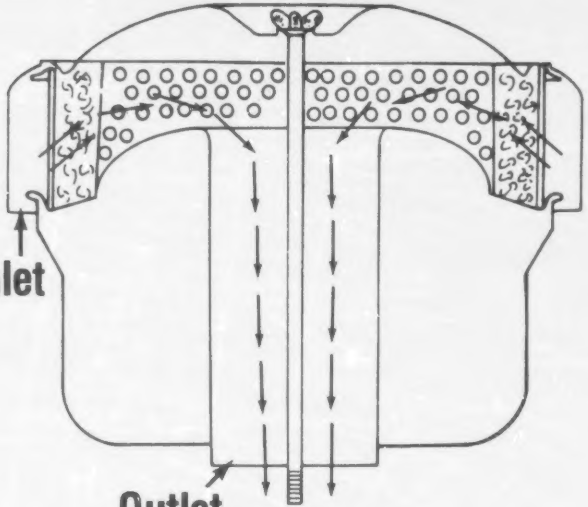

Air In
Air Out
Oil
Sediment

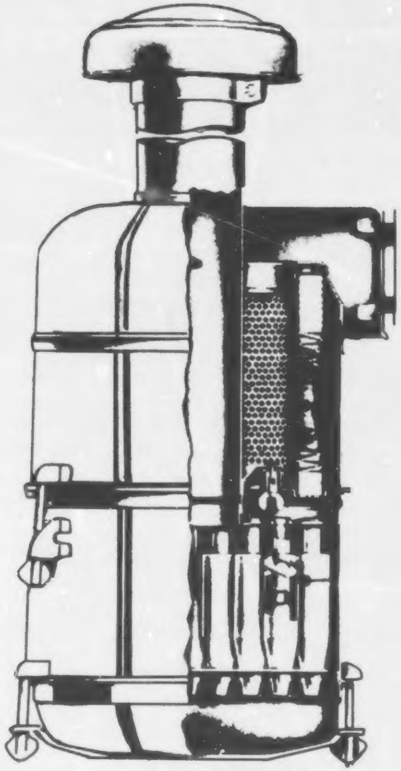
Used with permission of Waukesha Engine Division, Dresser Industries, Inc.

Types of Air Cleaners

(Continued)

Viscous-Impingement Air Cleaner

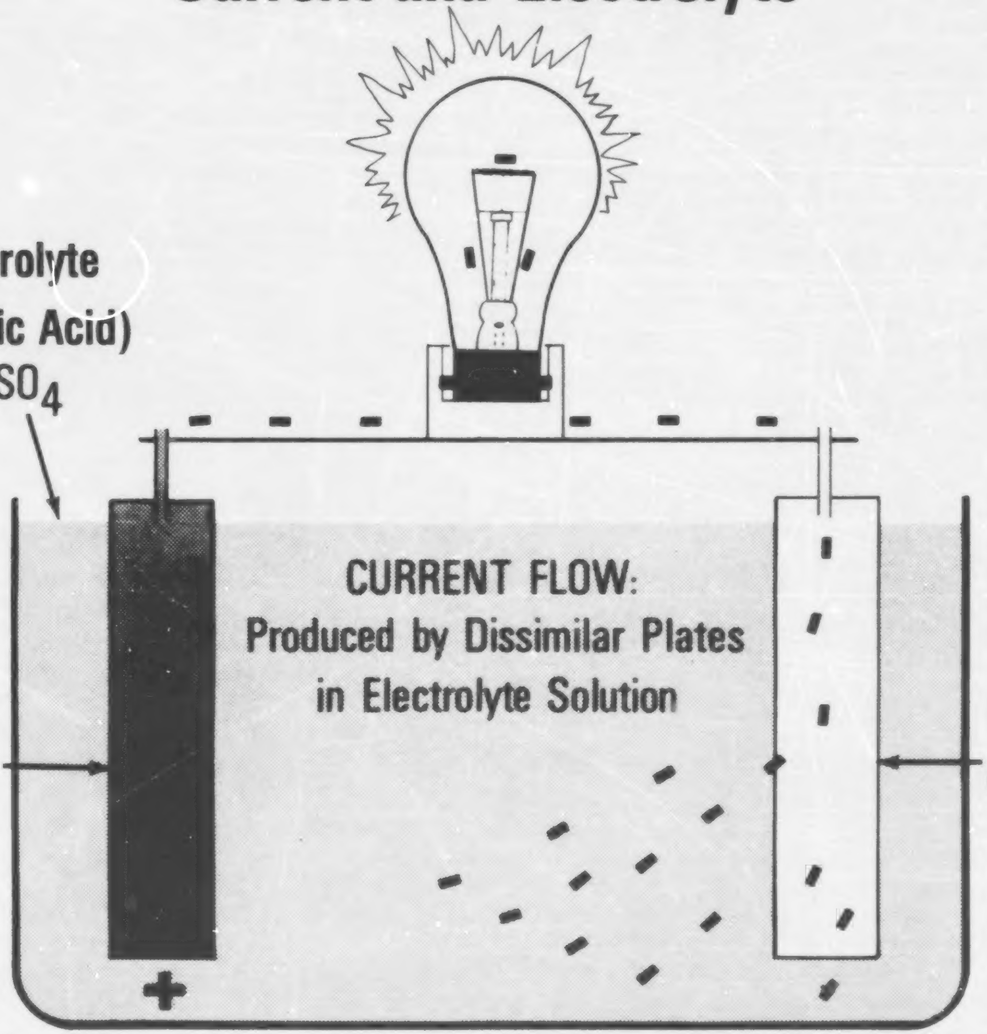




Dry-Element Air Cleaner

Used with permission of the Caterpillar Tractor Co.

Current and Electrolyte



Electrolyte
(Sulfuric Acid)
H_2SO_4

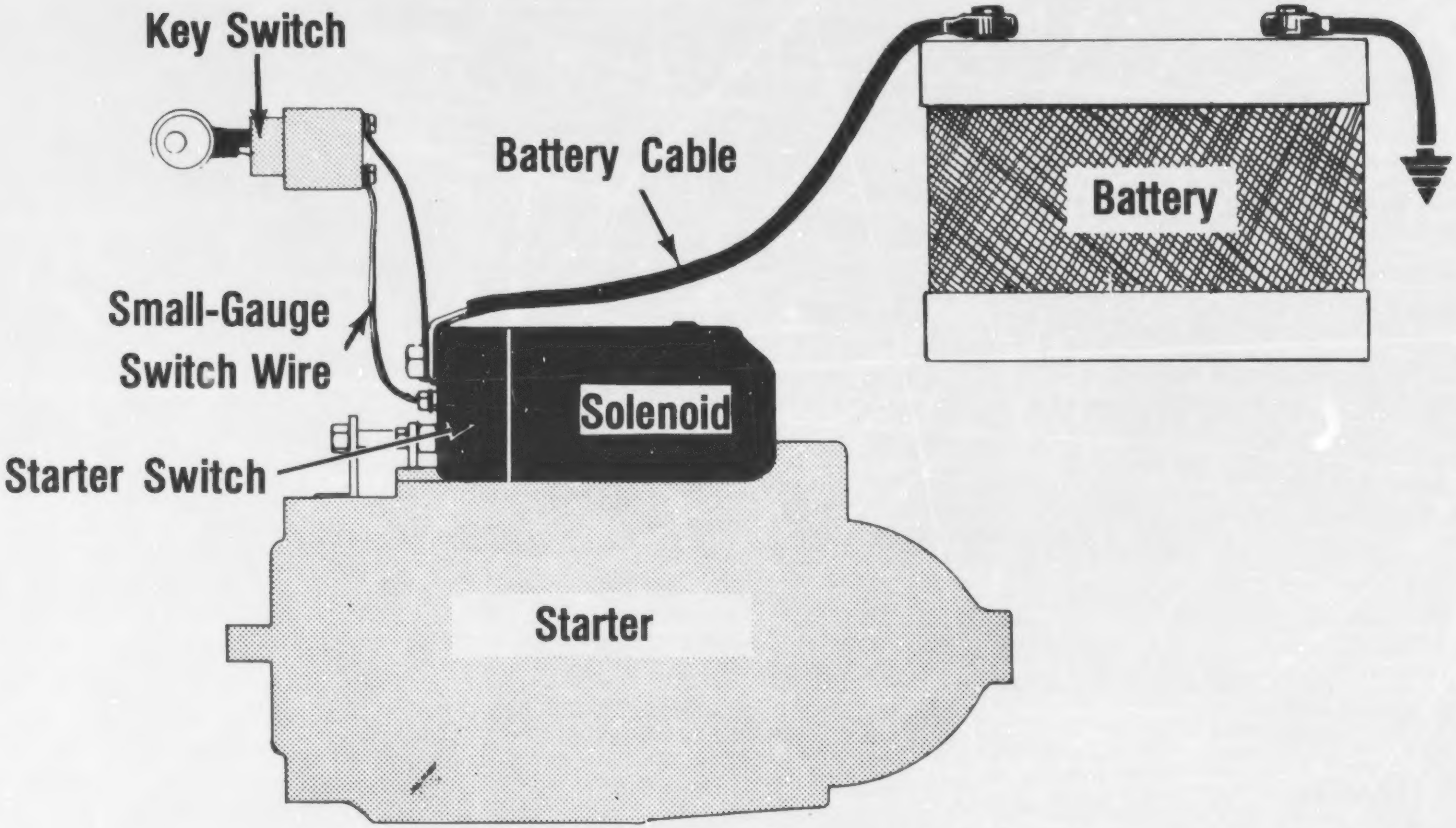
CURRENT FLOW:
Produced by Dissimilar Plates
in Electrolyte Solution

Positive Plate
(Lead Peroxide)

Negative Plate
(Sponge Lead)

How a Battery Converts Chemical Energy into Electrical Energy

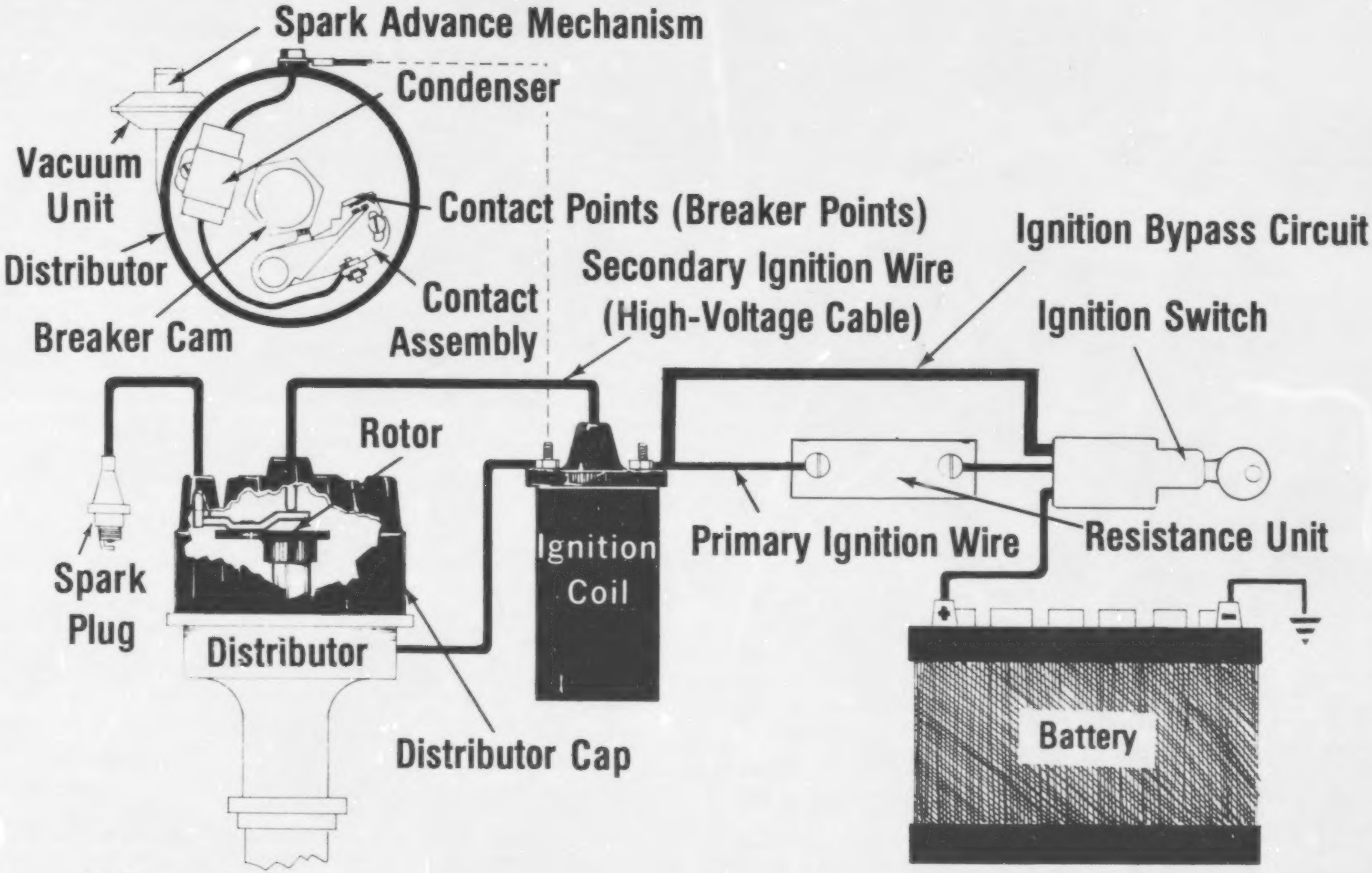
Components of the Starting System


Key Switch
Battery Cable
Battery
Small-Gauge Switch Wire
Solenoid
Starter Switch
Starter

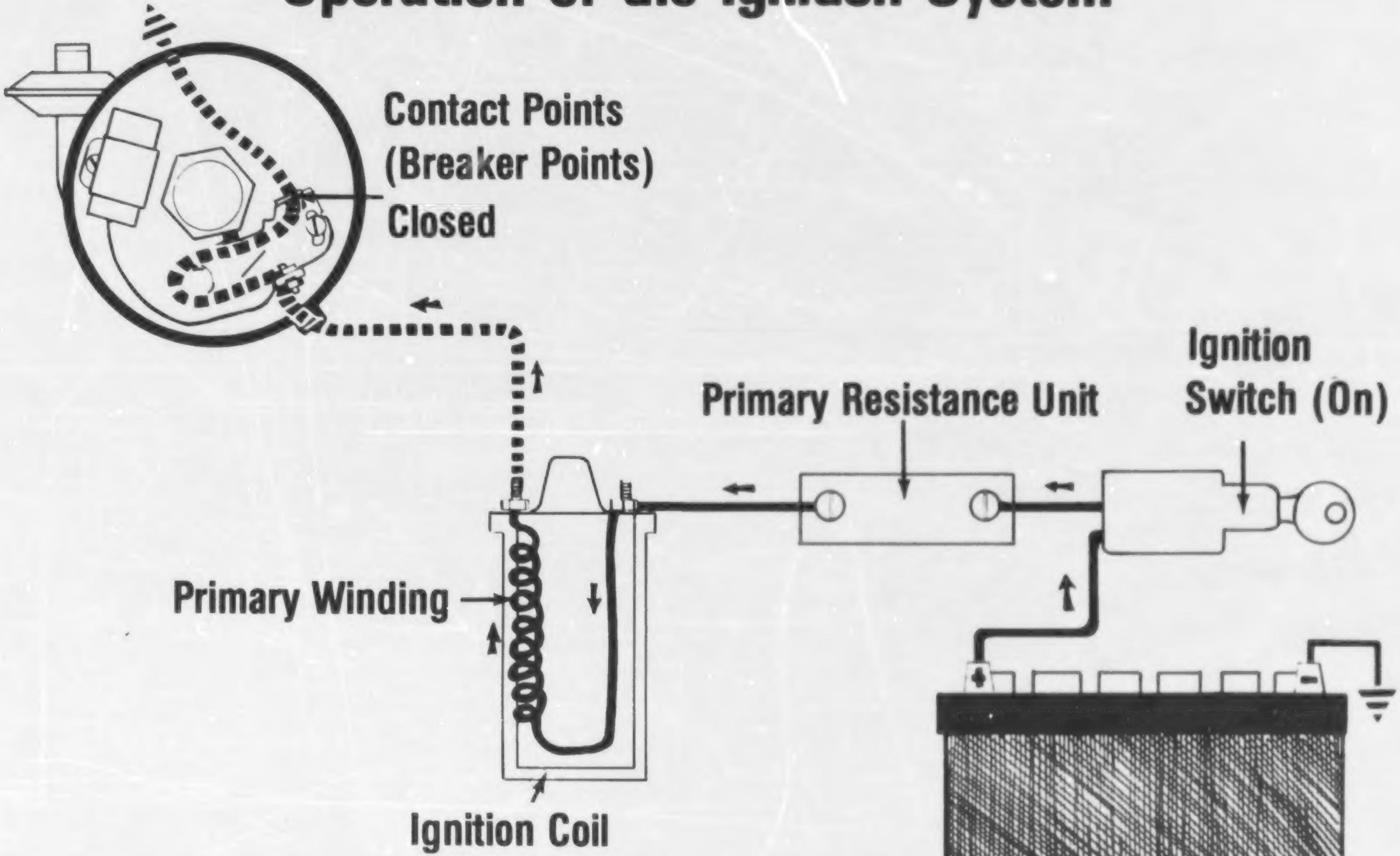
TM #12

DOT I-491

Major Components of the Ignition System

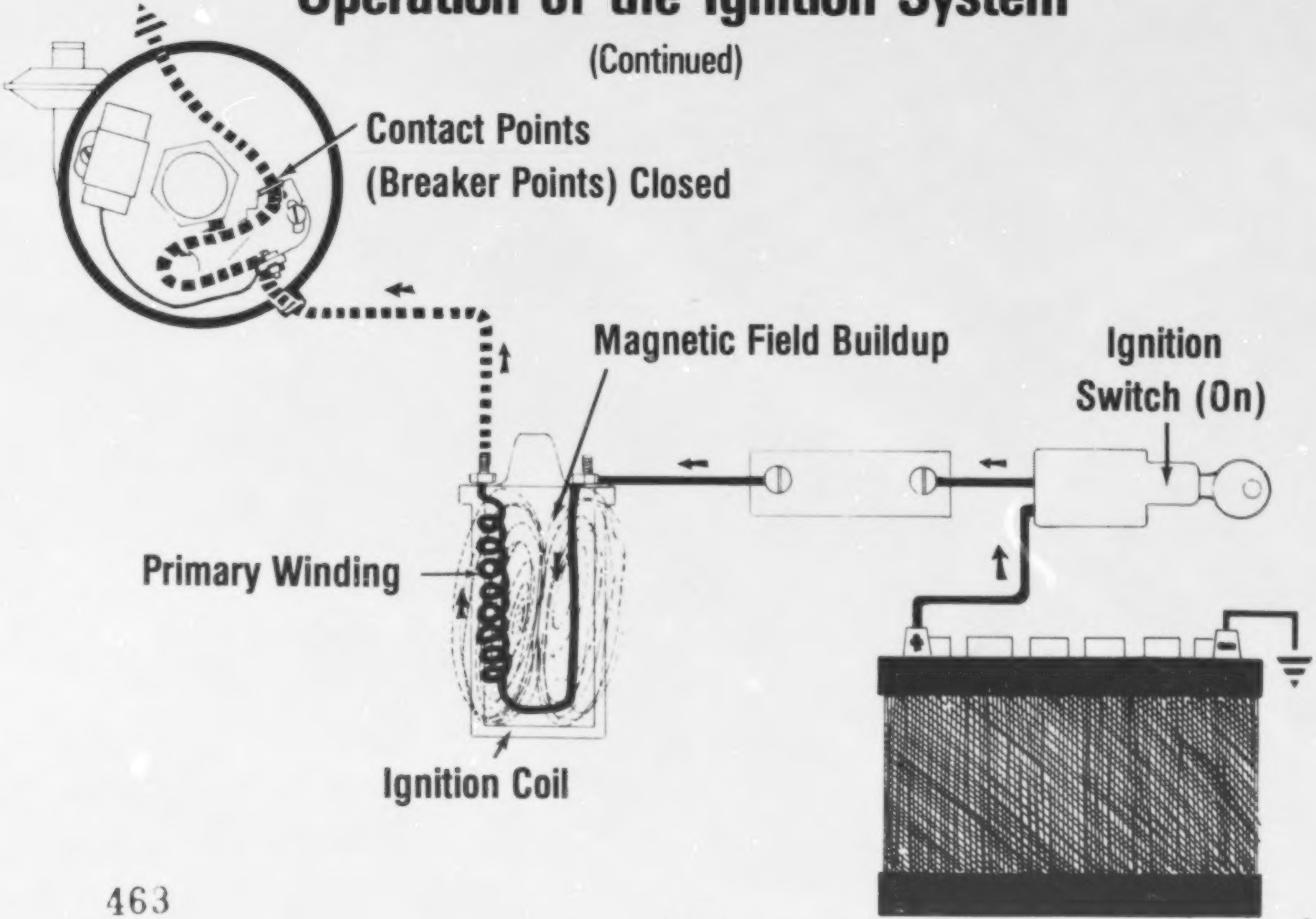

Spark Advance Mechanism
Condenser
Vacuum Unit
Contact Points (Breaker Points)
Ignition Bypass Circuit
Distributor
Secondary Ignition Wire (High-Voltage Cable)
Contact Assembly
Breaker Cam
Ignition Switch
Rotor
Ignition Coil
Primary Ignition Wire
Resistance Unit
Spark Plug
Distributor
Battery
Distributor Cap

Operation of the Ignition System


Contact Points
(Breaker Points)
Closed
Ignition
Switch (On)
Primary Resistance Unit
Primary Winding
Ignition Coil
+
-

Operation of the Ignition System

(Continued)



Contact Points
(Breaker Points) Closed

Magnetic Field Buildup

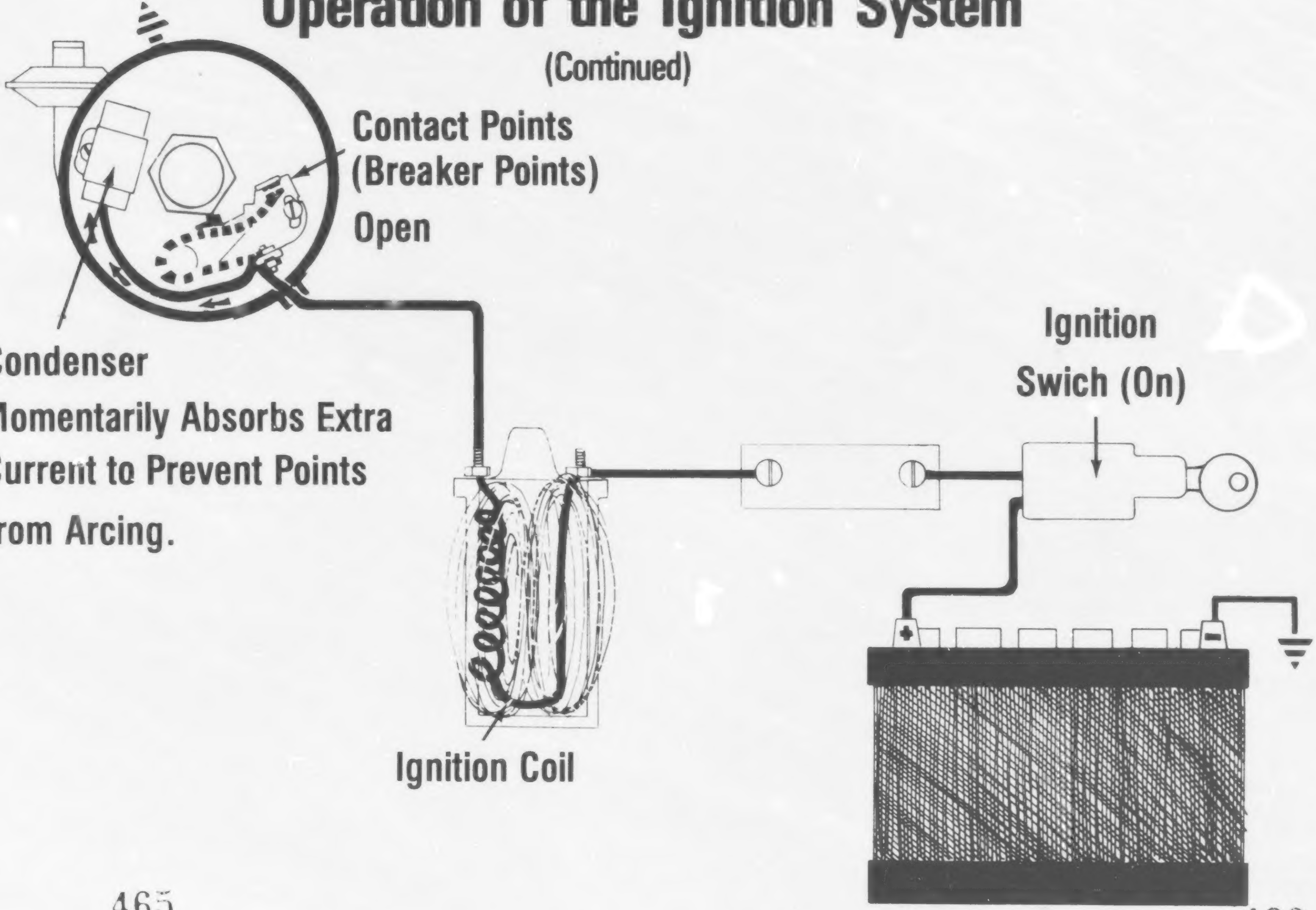
Ignition
Switch (On)

Primary Winding

Ignition Coil

Operation of the Ignition System

(Continued)



Contact Points
(Breaker Points)
Open

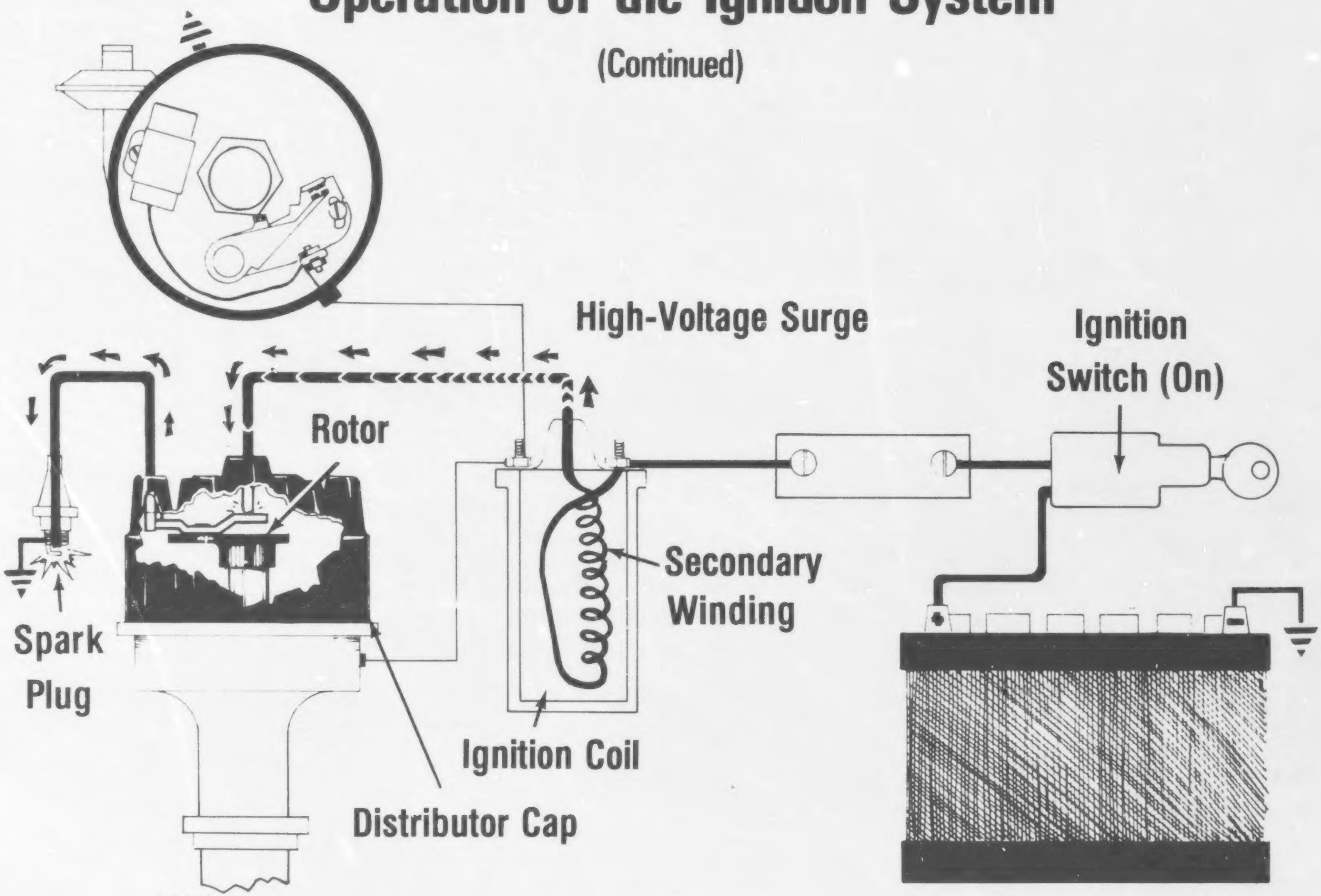
Condenser
Momentarily Absorbs Extra
Current to Prevent Points
from Arcing.

Ignition Coil

Ignition
Swich (On)

Operation of the Ignition System

(Continued)

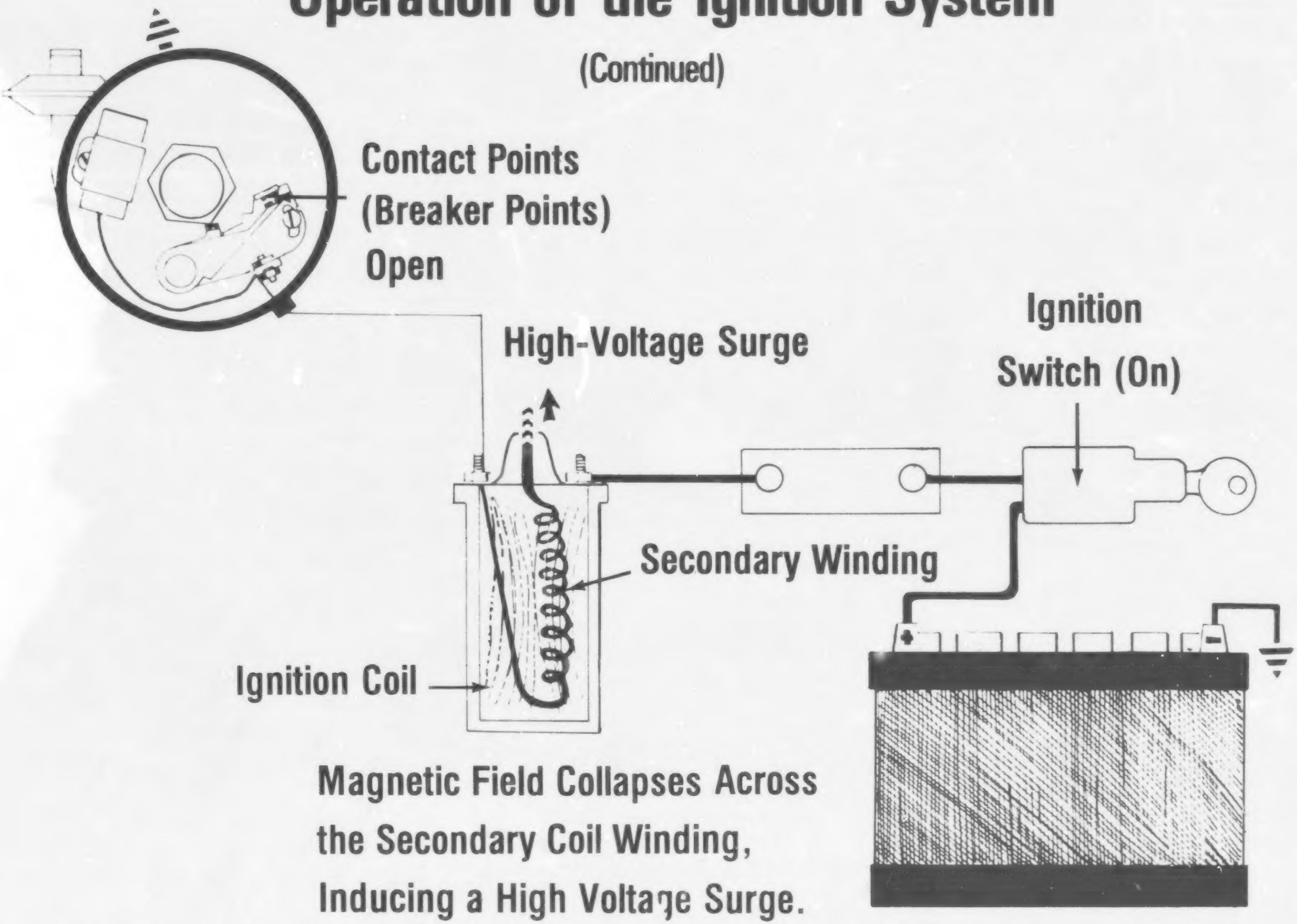

High-Voltage Surge
Ignition Switch (On)
Rotor
Secondary Winding
Spark Plug
Ignition Coil
Distributor Cap

TM #17

DOT I - 501

Operation of the Ignition System

(Continued)



Contact Points
(Breaker Points)
Open

High-Voltage Surge

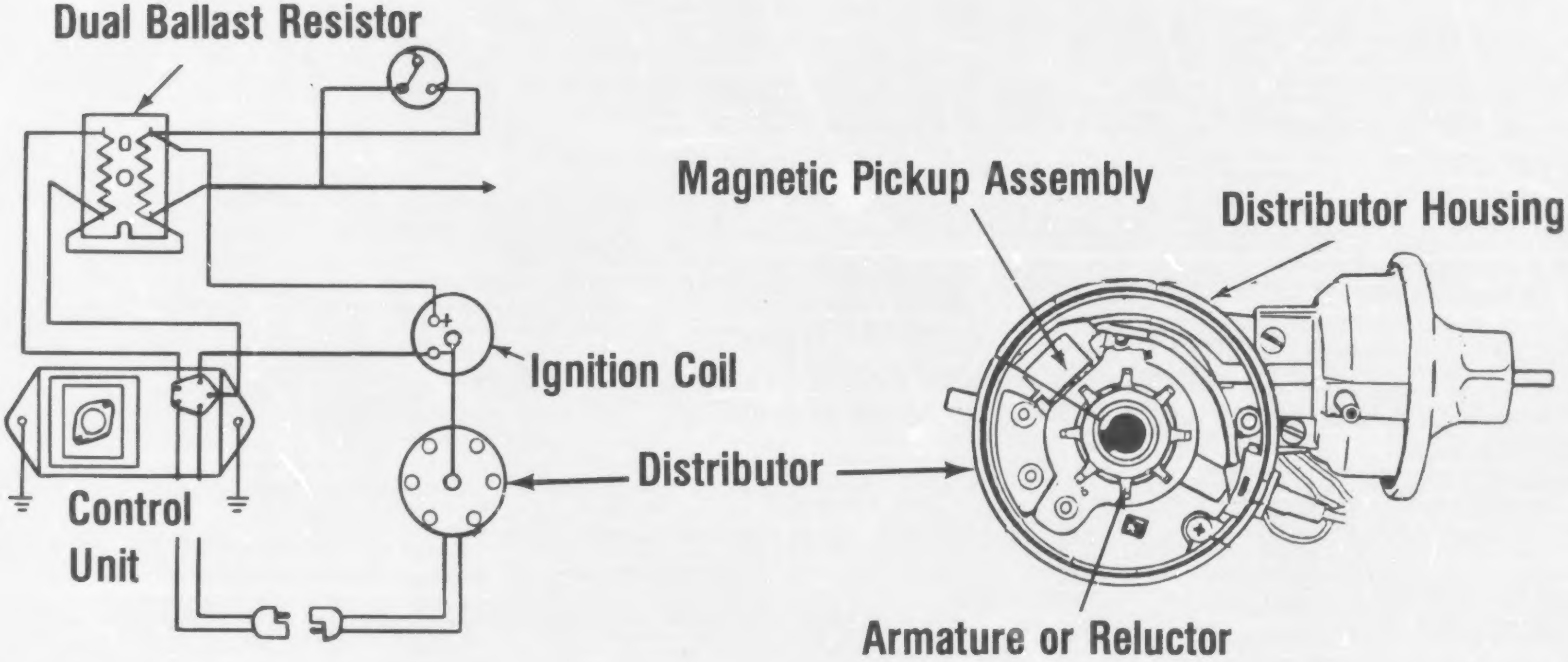
Ignition
Switch (On)

Secondary Winding

Ignition Coil

Magnetic Field Collapses Across the Secondary Coil Winding, Inducing a High Voltage Surge.

Major Components of the Electronic Ignition System



Dual Ballast Resistor

Magnetic Pickup Assembly

Distributor Housing

Ignition Coil

Distributor

Control Unit

Armature or Reluctor

PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #1--TEST ANTIFREEZE SOLUTION

I. Equipment--Antifreeze hydrometer tester

II. Procedure

A. Start engine and allow time for coolant to warm to operating temperature

B. Remove radiator cap

(CAUTION: Never remove radiator cap quickly when engine is hot. Loosen cap slowly to first stop; leave in this position until all pressure is released. Cap can then be removed safely.)

C. Draw antifreeze into tester and empty several times to equalize the temperature of all parts

D. Draw antifreeze into tester

E. Read the first number or letter on the float above the liquid surface

F. Note temperature of antifreeze

G. Measure antifreeze content of the water by comparing readings with chart on tester

(NOTE: The antifreeze content should be such that the cooling system would be protected to 10°F lower than the coldest temperature expected.)

H. Add antifreeze if necessary

(NOTE: If antifreeze is added, it is necessary to drain old antifreeze from the system to make room for the new that is added. Be sure to allow room for expansion.)

PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #2--SERVICE AN AIR CLEANER

I. Tools and equipment

- A. Compressed air
- B. Container of solvent
- C. Cleaning brush
- D. Shop towels
- E. Screwdriver

II. Procedure

- A. Remove the air cleaner fasteners
- B. Remove the air cleaner and air cleaner cover
- C. Clean element

(NOTE: Determine the type of air cleaner element, and follow procedure below.)

1. Paper air cleaner element

   (NOTE: Replace at specified intervals.)

   a. Tap lightly on a flat surface or direct a controlled stream of compressed air through the element opposite normal air flow (Figures 3 and 4)

FIGURE 3

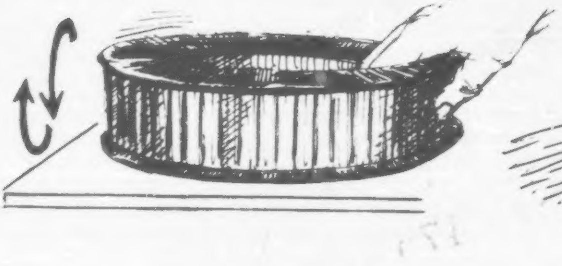
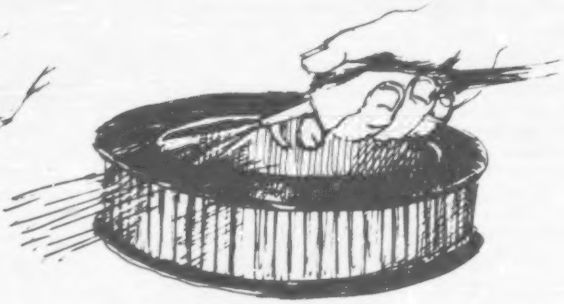


FIGURE 4



JOB SHEET #2

   b. Check the element against a light before reinstalling to make sure that there are no holes or ruptures

   c. Check bottom and top gasket surfaces of element for damage

   d. Install right side up where indicated

2. Polyurethane element

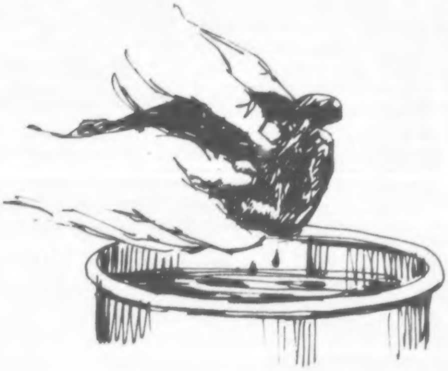
   a. Remove element from support screen

   b. Wash element thoroughly in clean solvent

   c. Squeeze out solvent (Figure 5)

      (NOTE: Do not wring because element might tear.)

FIGURE 5



JOB SHEET #2

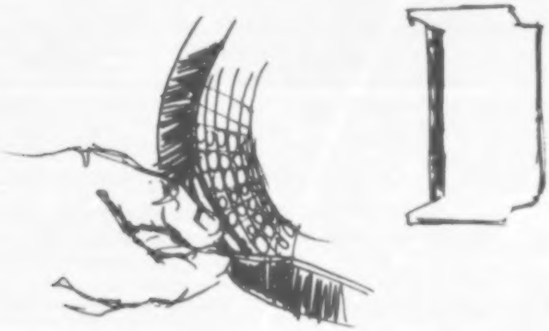
d. Re-oil filter element with clean engine oil

e. Squeeze excess oil from filter element

f. Replace element on support screen (Figure 6)

(NOTE: Make sure the element is placed on the support screen to form a sound seal for both top and bottom contact edges.)

FIGURE 6

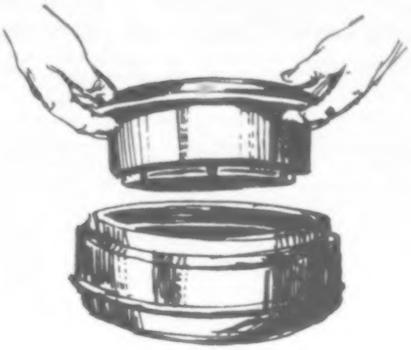


3. Oil bath air cleaner

a. Remove wing nut

b. Lift out gauze air strainer (Figure 7)

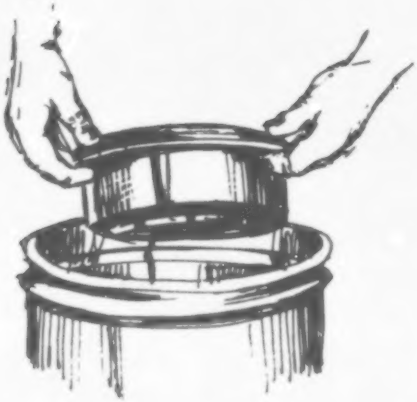
FIGURE 7



JOB SHEET #2

c. Rinse air strainer in clean solvent (Figure 8)

FIGURE 8



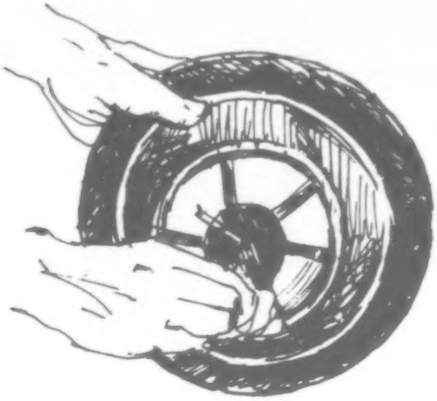
d. Shake excess solvent from air strainer

e. Saturate air strainer gauze with light oil and allow excess to drip off

f. Pour out and discard oil in lower body

g. Wash dirt and grit out of lower body with clean soivent (Figure 9)

FIGURE 9

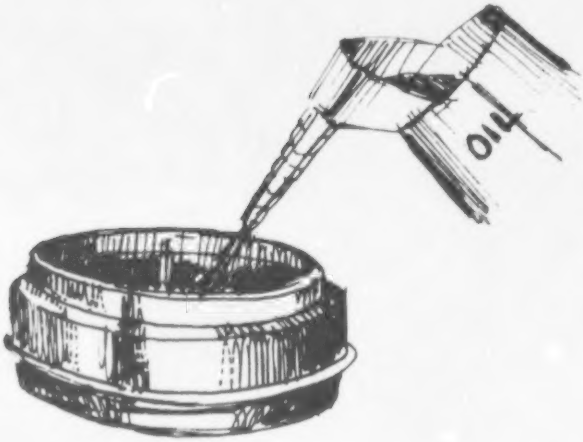


JOB SHEET #2

h. Fill lower body to correct level with fresh engine oil of sufficient SAE specification (Figure 10)

(NOTE: Do not overfill.)

FIGURE 10



i. Place units together; install wing nut

(NOTE: Make sure gasket is in place between the air strainer and lower body.)

j. Tighten wing nut securely

D. Clean the filter body; and cover before replacing

E. Make certain that the gasket between the air cleaner and carburetor is in good condition and is in place; replace if necessary

F. Replace air cleaner body

(NOTE: Make sure the air cleaner faces the correct direction. If a locating lug is present, make sure it engages properly.)

G. Tighten the air cleaner wing nut

(NOTE: Tighten with fingers only; do not overtighten.)

H. Install other hoses or vacuum lines as required

PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #3--CLEAN AND SERVICE A BATTERY

I. Tools and equipment

  A. Full face shield

  B. Rubber gloves

  C. Rubber apron

  D. Bristle brush

  E. Wire brush

  F. Screwdriver

  G. Battery clamp puller

  H. Combination end wrenches, 7/16" - 9/16"

  I. Baking soda and water solution (two tablespoons of baking soda to one pint of water)

  J. Battery anti-corrosion paste

  K. Shop towels

II. Procedure

  A. Disconnect battery cables from battery posts

  (NOTE: Always disconnect the grounded battery cable first to avoid short circuits. Use care to avoid twisting the battery cable post.)

    1. Pry clamp open (Figures 11 and 12)

FIGURE 11

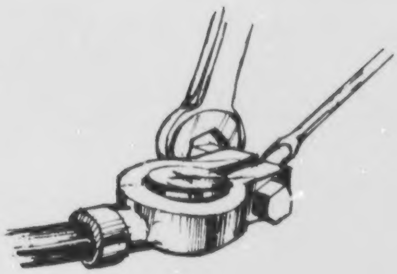
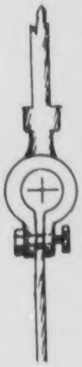


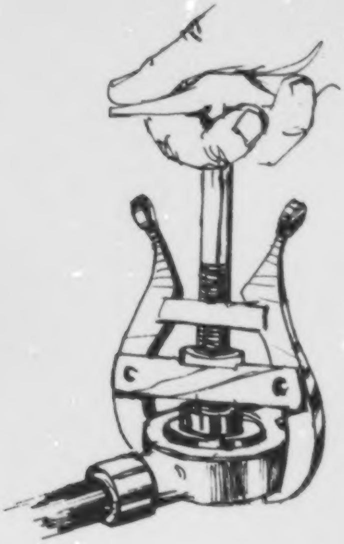
FIGURE 12



JOB SHEET #3

2. Pull cable off (Figure 13)

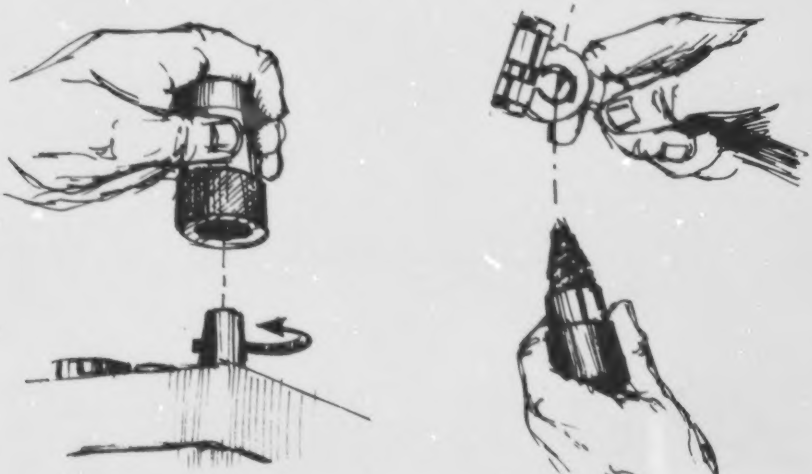
FIGURE 13



B. Clean battery cable clamps and battery post (Figure 14)

(NOTE: Battery posts and inside of battery cable clamps must be clean and bright.)

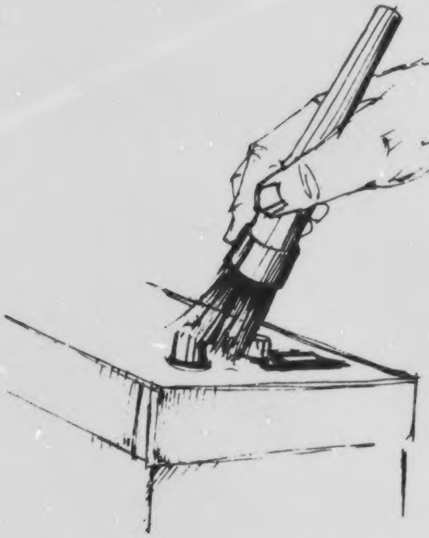
FIGURE 14



JOB SHEET #3

C. Remove loose dirt and corrosion particles from top of battery (Figure 15)

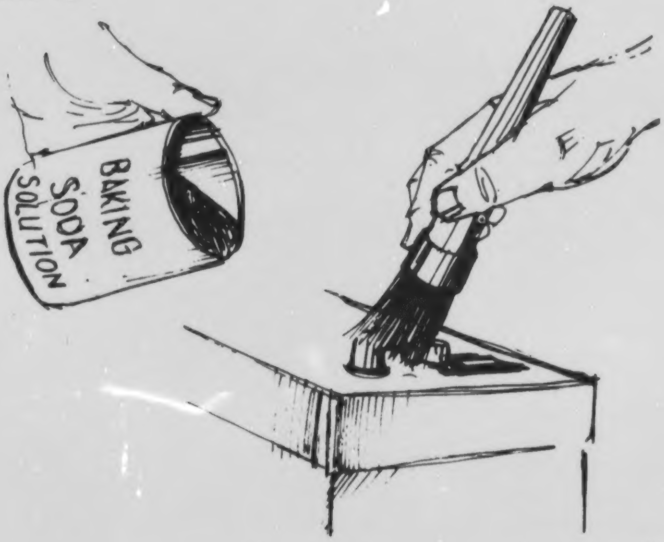
FIGURE 15



D. Brush soda-water solution on battery, battery post, clamps, and battery hold-down (Figure 16)

(NOTE: Keep water and soda from entering the battery through the vent holes in the vent caps.)

FIGURE 16

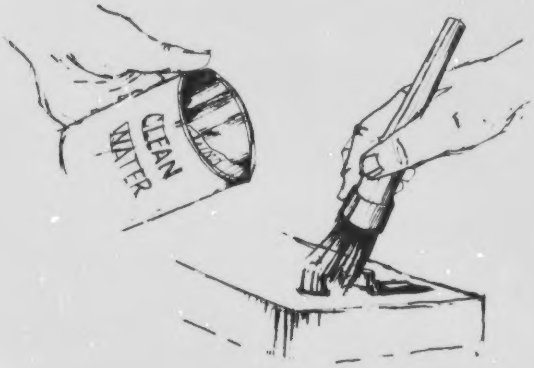


JOB SHEET #3

E. Wash away residue with clean water (Figure 17)

(NOTE: Remove all residue that may have lodged around battery, frame, or parts of the vehicle.)

FIGURE 17

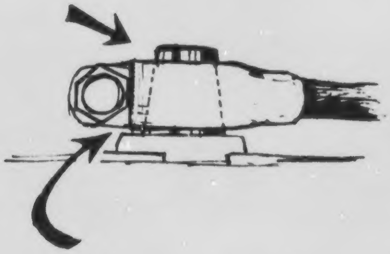


F. Dry battery and battery cables with a clean cloth

G. Reconnect battery cables to battery posts (Figure 18)

(CAUTION: Always reconnect the power cable first and the ground cable last.)

FIGURE 18



H. Spread a coating of battery anti-corrosion paste over the cable clamps and terminals

I. Remove vent caps

J. Check electrolyte level in all cells

K. Add water if necessary to bring electrolyte up to proper level

(NOTE: Do not overfill.)

PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #4--REMOVE AND REPLACE A BATTERY

I. Tools and equipment

- A. Full face shield
- B. Protective clothing
- C. Wire brush
- D. Screwdriver
- E. Battery clamp puller
- F. Combination end wrenches, 7/16" - 9/16"
- G. Battery cable spreader
- H. Battery post and cable cleaner
- I. Battery lift strap

II. Procedure

(NOTE: Observe the location of the positive post so that the battery can be installed in the same way.)

A. Disconnect battery cables from battery posts

(NOTE: Always disconnect the grounded battery cable first to avoid short circuits. Use care to avoid twisting the battery cable post.)

1. Pry clamp open (Figures 19 and 20)

FIGURE 19

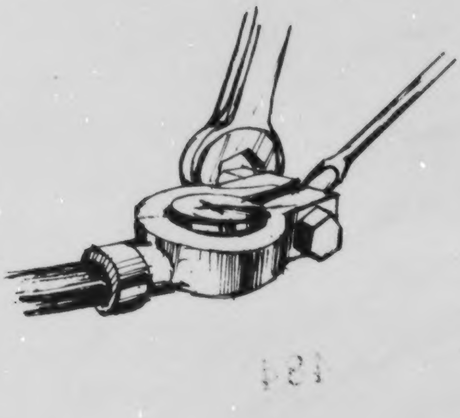
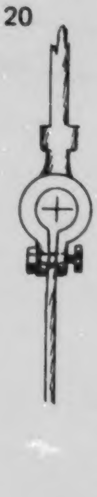


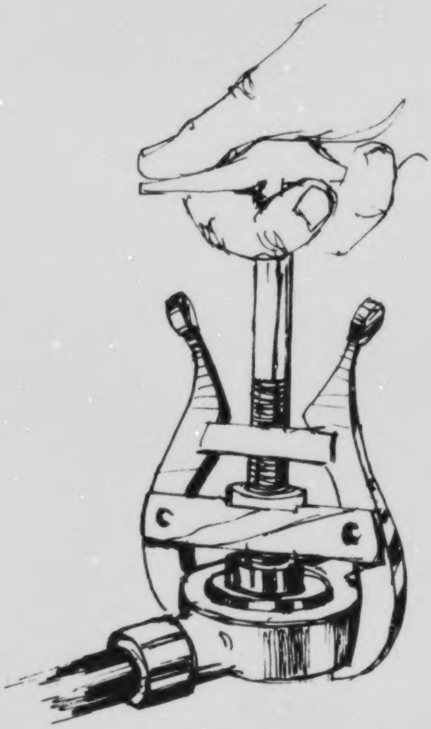
FIGURE 20



JOB SHEET #4

2. Pull cable off (Figure 21)

FIGURE 21



B. Remove battery hold-down

C. Remove battery from carrier

(NOTE: Use a suitable battery lift strap to lift battery.)

D. Inspect battery carrier for dirt or corrosion

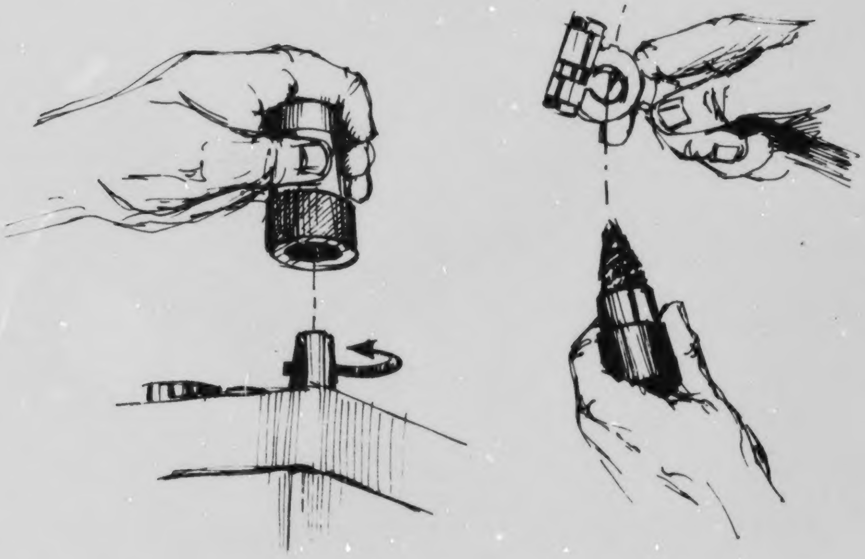
(NOTE: Clean with baking soda and water solution as required.)

E. Check battery cables for worn or frayed insulation

JOB SHEET #4

F. Clean inside of battery cables until bright (Figure 22)

FIGURE 22



G. Set battery into place using a lift strap

(NOTE: Position battery to allow for correct battery cable attachment.)

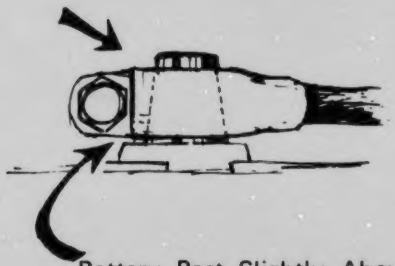
H. Install battery hold-down clamp or strap; tighten securely

JOB SHEET #4

I. Reconnect battery cables to battery posts (Figure 23)

(CAUTION: Always reconnect the power cable first and the ground cable last.)

FIGURE 23



Battery Post Slightly Above Clamp

J. Tighten battery cable clamps securely

(NOTE: Use care to avoid twisting battery cable post.)

K. Spread a coating of battery anti-corrosion paste over cable clamps and terminals

PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #5--MEASURE BATTERY ELECTROLYTE WITH A HYDROMETER

I. Tools and equipment

  A. Hydrometer

  B. Shop towels

  C. Water container

II. Procedure

  A. Remove vent caps from battery

  B. Insert the hydrometer into the first cell

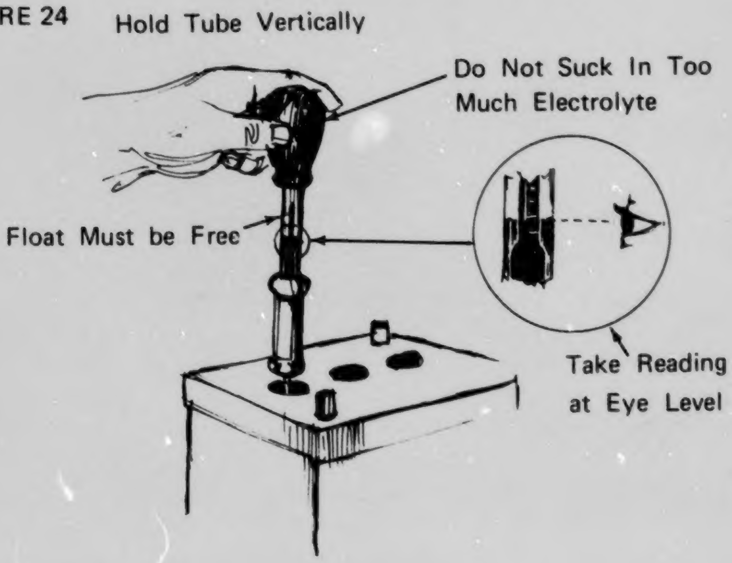
  C. Squeeze rubber bulb to draw electrolyte into hydrometer to suspend the float

  (NOTE: If electrolyte level is too low, add water until electrolyte level is correct; charge for one hour, and recheck.)

  D. Take reading at eye level (Figure 24)

  (NOTE: Make sure the float is not bumping the top of hydrometer tube or sticking to the side of the tube. Write down reading for each cell.)

FIGURE 24


Hold Tube Vertically
Do Not Suck In Too Much Electrolyte
Float Must be Free
Take Reading at Eye Level

JOB SHEET #5

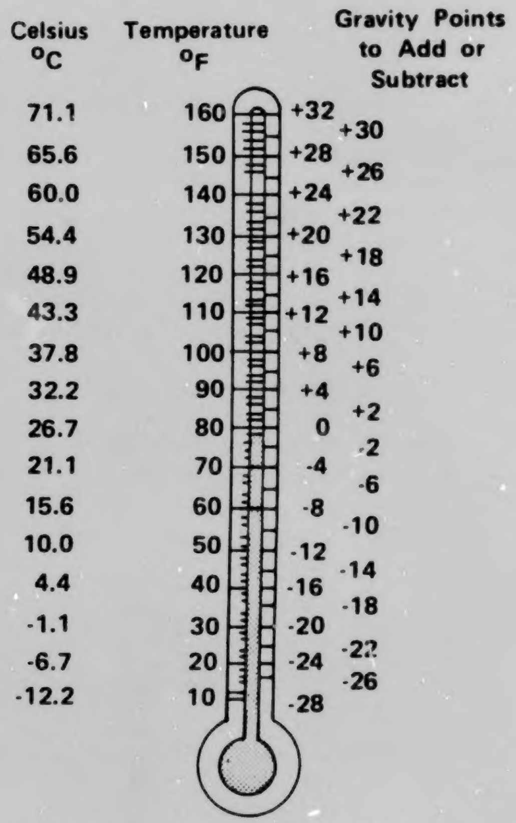
E. Squeeze bulb to return electrolyte to cell

F. Repeat for other cells

G. Adjust the readings for temperature (Figure 25)

1. Add four gravity points (0.004) to the reading for each 10°F (5.5°C) above 80°F (26.7°C)
2. Subtract four gravity points (0.004) for each 10°F (5.5°C) below 80°F (26.7°C)

FIGURE 25



Temperature Adjustment Chart

(NOTE: Specific gravity should read from 1.215 to 1.270, corrected for 80°F [26.7°C] electrolyte temperature. The variation in readings between cells should be no more than 0.050. If the readings are not within this range, further testing will be required.)

H. Replace vent caps upon completion of test

I. Flush any spilled electrolyte with clean water

PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #6--START AN ENGINE USING A NEGATIVE-GROUND BOOSTER BATTERY

I. Equipment

- A. Two engines
- B. Battery booster cables
- C. Shop cloths
- D. Face shield
- E. Rubber gloves
- F. Wire brush
- G. Negative-ground booster battery system

II. Procedure

(NOTE: This procedure is Ford's recommendation for using a jumper between two vehicles [for a negative-ground battery].)

(CAUTION: Use care in connecting a booster battery to avoid hurting yourself or damaging engine's electrical system.)

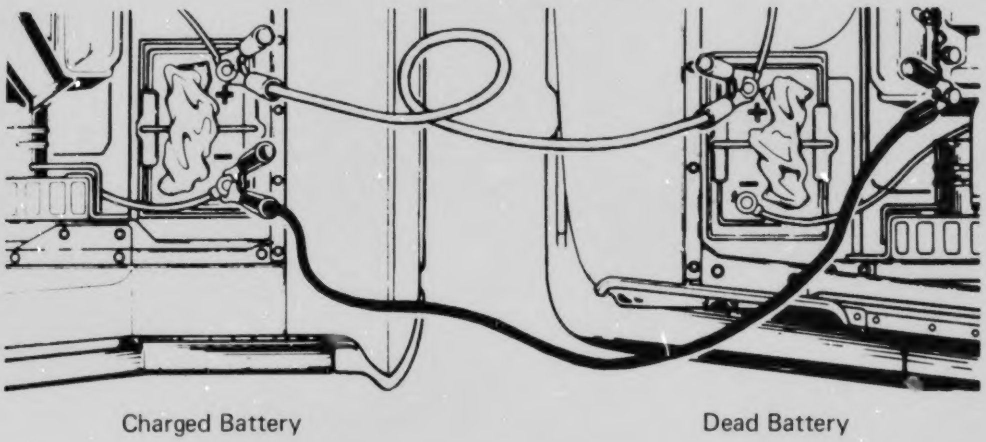
- A. Put on face shield and rubber gloves
- B. Use wire brush to clean connectors on battery
- C. Remove vent caps from both batteries
- D. Cover vent holes with shop cloths to prevent splashing of electrolyte
- E. Do not allow two machines to touch each other (if applicable)
- F. Be sure all electrical equipment is turned off, on engine to be started
- G. Connect end of one cable to the positive (+) terminal of the booster battery
- H. Connect other end of cable to positive (+) terminal of dead battery
- I. Connect one end of second cable to negative (-) terminal of booster battery

JOB SHEET #6

J. Connect other end of second cable to engine block of engine you are trying to start (Figure 26)

(CAUTION: DO NOT connect second cable to negative [grounded] terminal of engine you are trying to start. This will prevent arcing around battery and a possible explosion.)

FIGURE 26



From *Automotive Mechanics*, 8th ed. page 275, Figure 27.1, copyright 1980. Used with permission of McGraw-Hill Book Company.

K. Start engine which has the booster battery

(NOTE: After starting, let engine run for a few minutes to help restore power to low battery.)

L. Start engine which has the low battery

M. Disconnect cable from engine block (providing engine started)

N. Disconnect other end of this cable

O. Disconnect second cable from engine with low battery

P. Disconnect other end of second cable from engine which has the booster battery

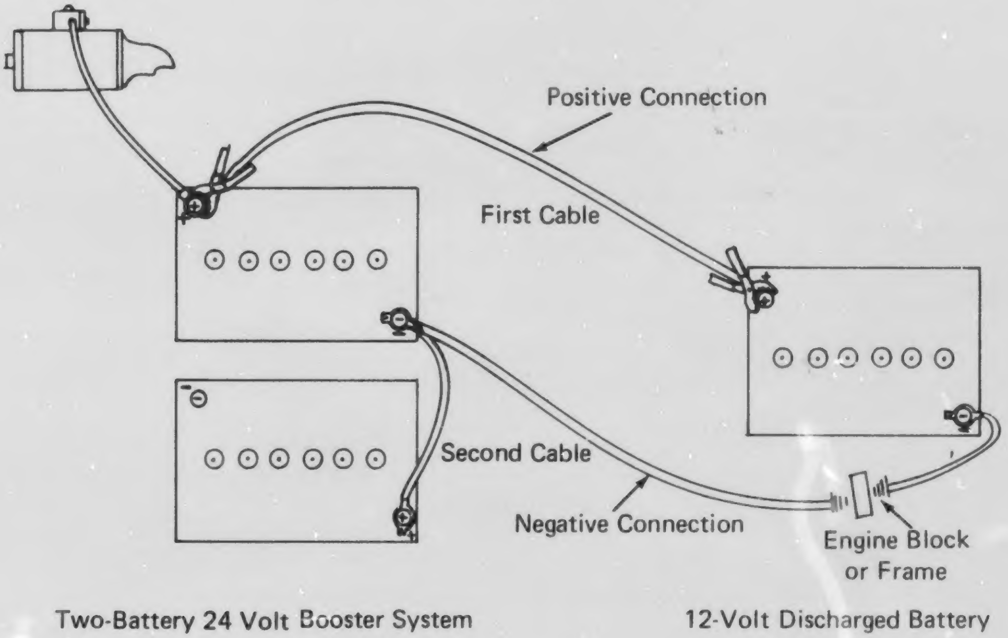
(CAUTION: Never operate starting motor for more than 30 seconds at a time. Pause for a few minutes to allow it to cool off, and then try again.)

PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #7--USE A 24-VOLT BATTERY BOOSTER SYSTEM TO START A VEHICLE WITH A 12-VOLT SYSTEM

(NOTE: This type of ground system [either positive (+) or negative (-)] can be boosted if both battery polarities are the same. See Figure 27.)

FIGURE 27


Positive Connection
First Cable
Second Cable
Negative Connection
Engine Block or Frame
Two-Battery 24 Volt Booster System
12-Volt Discharged Battery

(CAUTION: DO NOT use SINGLE 24-volt battery to boost a 12-volt battery.)

I. Equipment

  A. Two vehicles

  B. Battery booster cables

  C. Face shields

  D. Two battery, 24-volt booster system

  E. Twelve-volt discharged battery

  F. Shop cloths

  G. Rubber gloves

JOB SHEET #7

II. Procedure

(CAUTION: Use care in connecting booster battery to avoid hurting yourself or damaging the electrical equipment.)

A. Position vehicles close enough together for booster cables to reach batteries easily

(NOTE: Do not allow the two vehicles to touch each other. If the electrical systems in the two vehicles are not compatible, connecting them by allowing the vehicles to touch could cause serious damage.)

B. Make sure all electrical equipment except the ignition is turned off on the vehicle you are trying to start

C. Put on face shield and rubber gloves

D. Remove vent caps from both batteries

(NOTE: Cover the battery vent holes with shop cloths to prevent splashing of electrolyte.)

E. Connect end of one cable to the positive (+) terminal of the booster battery

F. Connect other end of cable to positive (+) terminal of discharged battery

(CAUTION: Never stand over battery when connecting cables.)

G. Connect one end of second cable to negative (-) terminal of booster battery

H. Connect other end of second cable to engine block or frame of the vehicle you are trying to start

(CAUTION: Do not connect second cable to negative (-) terminal of the vehicle battery as this could ignite any hydrogen in the battery and produce a serious explosion.)

I. Start vehicle which has the booster battery

(NOTE: Let engine idle a few minutes before trying to start other vehicle.)

J. Start vehicle with the discharged battery

(CAUTION: Never operate starting motor for more than 30 seconds at a time. Pause for a few minutes to allow it to cool off; then try again.)

JOB SHEET #7

K. Disconnect booster cables after disabled vehicle has started

L. Disconnect negative cable from engine block or frame first

M. Disconnect other end of negative cable from booster battery

N. Disconnect the other cable from positive terminals

PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #8--REMOVE AND REPLACE CONTACT POINTS AND CONDENSER

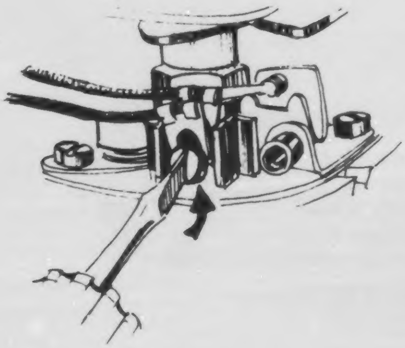
I. Tools and materials

- A. Basic hand tool set
- B. Ignition wrenches
- C. Feeler gauges, 0.010" - 0.025"
- D. Distributor cam lubricant
- E. Point alignment tools
- F. Timing light
- G. Shop towel
- H. Safety glasses

II. Procedure

- A. Remove distributor cap and place out of the way
- B. Remove rotor
- C. Determine condition of contact points and location of wires, screws, and eccentric as used
- D. Disconnect contact point primary lead wire and condenser wire by loosening screw (Figure 28)

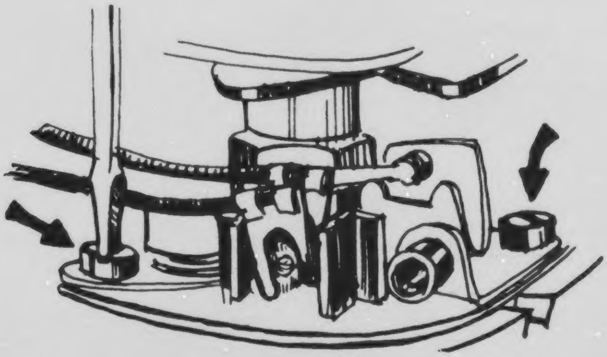
FIGURE 28



JOB SHEET #8

E. Loosen screws holding contact points in place (Figure 29)

FIGURE 29



F. Remove contact point set

G. Remove screw holding condenser in place

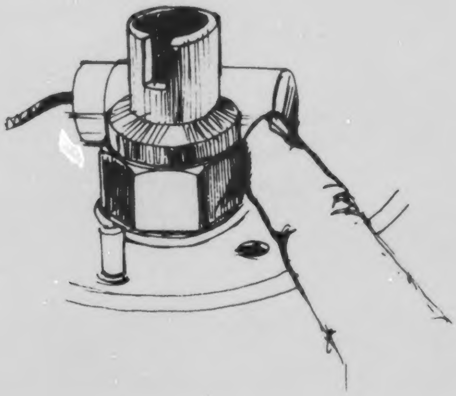
H. Remove condenser

I. Clean breaker plate and distributor cam

J. Lubricate distributor cam with a light coat of cam lubricant (Figure 30)

(NOTE: On distributors with the centrifugal weights accessible, place a drop of light oil on each weight pivot post.)

FIGURE 30



JOB SHEET #8

K. Place the contact points in distributor and install attaching screws

L. Replace condenser and attaching screws; tighten securely

M. Replace the primary lead and condenser wires

(NOTE: Position the wires in such a manner as to avoid binding or grounding.)

N. Tighten primary lead and condenser wires securely

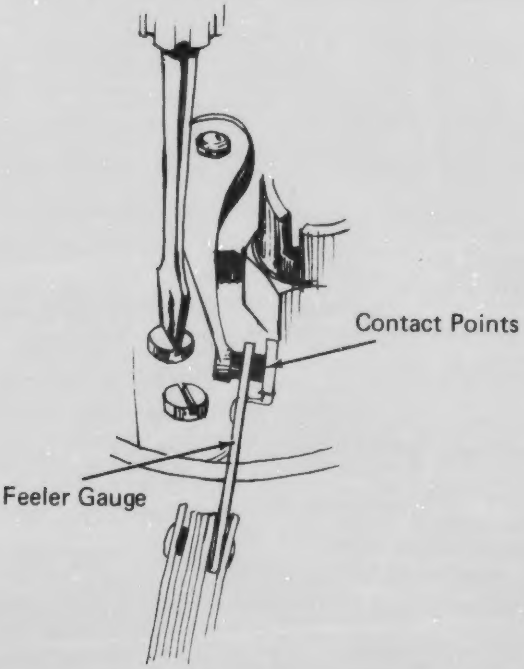
O. Check point alignment and adjust if required

P. Check contact point breaker spring tension

Q. Adjust contact point opening (Figure 31)

(NOTE: Crank the engine to position the rubbing block of the contact points on the peak of the cam lobe.)

FIGURE 31



JOB SHEET #8

R. Adjust contact points according to operator's manual

S. Tighten contact point attaching screws securely; recheck contact point opening

T. Install rotor

(NOTE: Make sure rotor is positioned correctly and is secure.)

U. Install distributor cap

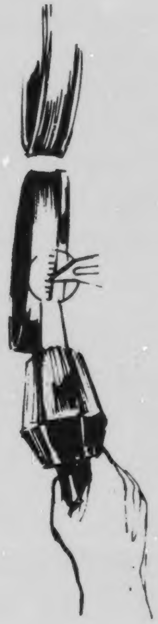
(NOTE: Make sure distributor is positioned correctly and is secure.)

V. Replace distributor in engine if removed

W. Start engine

X. Set timing to manufacturer's instructions (Figure 32)

FIGURE 32



PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #9--REMOVE, SERVICE, AND REPLACE SPARK PLUGS

I. Tools and materials

A. Spark plug socket, 3/8" drive

B. Ratchet, 3/8" drive

C. Extensions, 3", 6", 10", by 3/8" drive

D. Spark plug cleaner

E. Wire brush

F. Small point file

G. Shop towels

H. Safety glasses

I. Torque wrench

II. Procedure

A. Remove spark plug wires

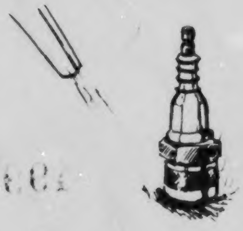
(NOTE: Pull the wire from the spark plug by grasping the terminal, no by pulling on the wire.)

B. Loosen the spark plugs

C. Clean the area around the spark plug by blowing, wiping, or brushing (Figure 33)

(NOTE: Wear safety glasses to protect your eyes when using compressed air.)

FIGURE 33

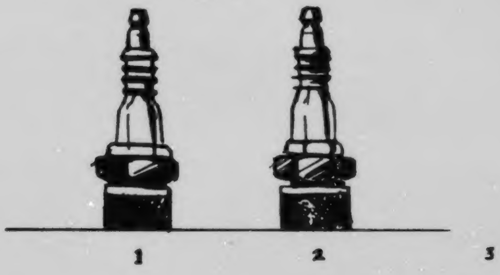


JOB SHEET #9

D. Remove the spark plugs

(NOTE: Arrange the spark plugs in order as they are removed. The condition of the spark plug can tell a lot about the operation of a particular cylinder. See Figure 34.)

FIGURE 34

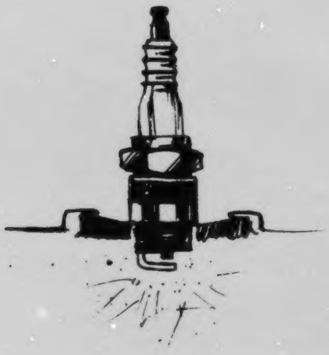


E. Remove spark plug gaskets, if used

F. Determine condition of spark plugs and decide whether to replace or service

G. Service by cleaning spark plugs on a spark plug cleaning machine (Figure 35)

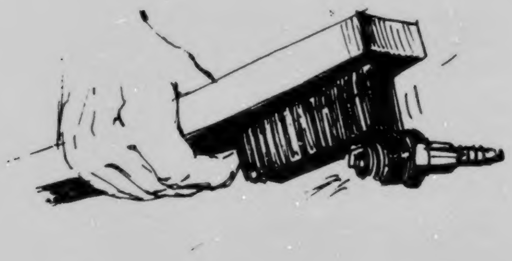
FIGURE 35



JOB SHEET #9

H. Clean the thread with a wire hand brush (Figure 36)

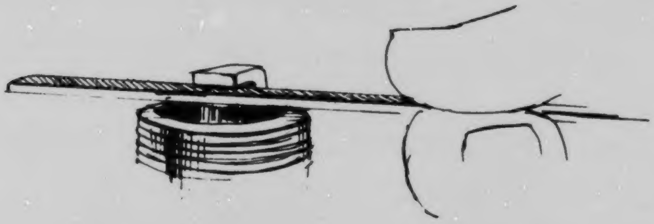
FIGURE 36



I. Bend the ground electrode slightly to open gap

J. File the center electrode to flatten the surface and square up the edges (Figure 37)

FIGURE 37



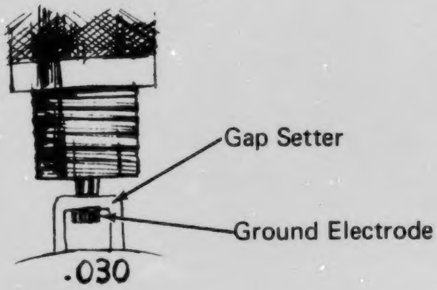
JOB SHEET #9

K. Reset gap on new and serviced spark plugs to manufacturer's instructions (Figure 38)

(NOTE: Use a wire gauge to check the gap. Make sure the electrode surfaces are parallel. Regap every time plugs are serviced.)

(CAUTION: Bend only the ground electrode.)

FIGURE 38



L. Install new spark plug gaskets if required

M. Install spark plugs and tighten

(NOTE: To avoid cross threading, use caution when starting to install spark plugs.)

N. Torque spark plugs to manufacturer's instructions

O. Replace spark plug wires in proper order

(NOTE: Push spark plug wires securely into place, making sure that they are in the brackets or holders.)

PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #10--CHANGE OIL IN AN ENGINE

I. Tools and equipment

- A. Drain pan
- B. Wrench suitable for drain plug removal
- C. Jack
- D. Jack stands, 4
- E. Oil spout
- F. Service sticker
- G. Shop towels

II. Procedure

(CAUTION: Never get under improperly supported vehicle.)

- A. Support vehicle on jack stands
- B. Position drain pan under engine drain plug
- C. Remove drain plug

  (CAUTION: Use care to avoid being burned by hot oil.)

- D. Allow the oil sufficient time to drain

  (NOTE: Observe oil condition and color that might make further service necessary.)

- E. Replace oil filter as required
- F. Replace drain plug

  (NOTE: Make sure the gasket, if used, is in place and the drain plug is securely tightened.)

- G. Remove jack stands and lower vehicle to floor
- H. Lift hood
- I. Remove oil filler cap

  (NOTE: Dirt and grease should be wiped away from filler cap before removal.)

JOB SHEET #10

J. Refill crankcase to recommended level with the proper motor oil

(NOTE: Make sure the tops of the oil cans and the filling spout are clean.)

K. Clean and replace oil filler cap

L. Start engine and operate it for a few minutes at low rpm

M. Check for oil leaks

N. Shut off engine

O. Check oil level on dipstick

(NOTE: Add oil as required by manufacturer's instructions. Do not overfill.)

P. Fill out service chart

(NOTE: Make sure that date, mileage or hourmeter reading, and type of oil are included on service chart.)

PRINCIPLES OF ENGINE OPERATION
UNIT VI

JOB SHEET #11--CHANGE AN OIL FILTER

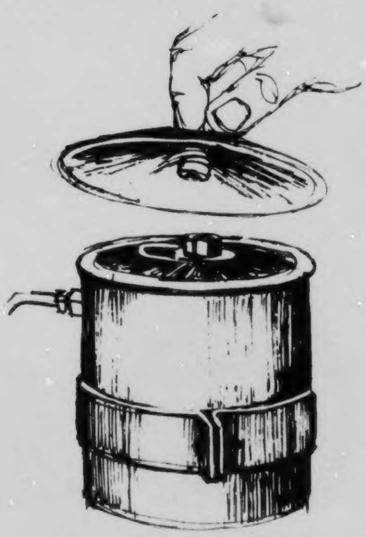
I. Tools and equipment

- A. Shop towels
- B. Container to catch waste oil
- C. Suitable wrenches to remove filter
- D. Fender covers
- E. Suction gun
- F. Jack
- G. Jack stands, 4

II. Procedure

- A. Replaceable-element type oil filter on upper part of engine
  1. Clean dirt from filter cover
  2. Remove oil filter cover (Figure 39)

FIGURE 39



JOB SHEET #11

3. Remove oil filter element

   (NOTE: Use care to avoid spilling oil on vehicle.)

4. Remove remaining oil from filter housing by removing drain plug from housing, or use suction gun to draw out oil

5. Clean filter cover and housing

6. Remove old filter gasket

7. Install new filter gasket into filter cover

   (NOTE: Install other small rubber gaskets as required.)

8. Install new filter element

9. Install filter cover

   (NOTE: Make sure the gasket is in place.)

10. Tighten filter cover securely

11. Add oil or refill crankcase as required

12. Start engine

13. Check for leaks

14. Shut off engine

15. Check oil level on dipstick

    (NOTE: Add oil as required. Do not overfill.)

16. Make out service chart, indicating mileage and date that oil filter was changed

B. Replaceable-element type oil filter on lower part of engine

1. Support front of vehicle on jack stands

   (CAUTION: Never get under improperly supported vehicle.)

2. Position drain pan under oil filter

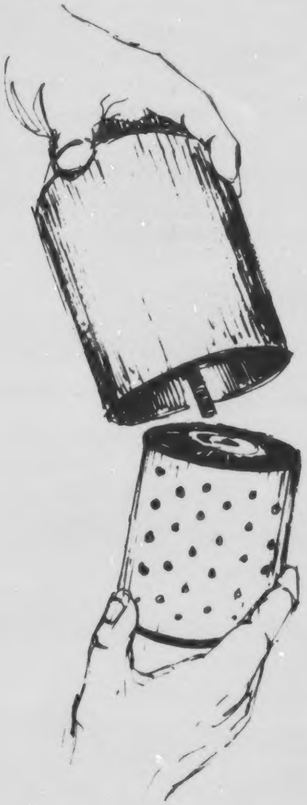
3. Remove oil filter housing bolt

4. Remove oil filter housing

JOB SHEET #11

5. Remove oil filter element from filter housing (Figure 40)

FIGURE 40



6. Clean filter housing
7. Remove old oil filter housing gasket
8. Install new oil filter housing gasket

   (NOTE: Make sure the new gasket is placed correctly.)
9. Install new oil filter element in filter housing
10. Install oil filter housing and tighten bolt securely
11. Remove jack stands and lower vehicle to floor
12. Add oil or refill crankcase if required
13. Start engine
14. Check for leaks

JOB SHEET #11

15. Shut off engine

16. Check oil level on dipstick

    (NOTE: Add oil if required. Do not overfill.)

17. Fill out service chart, indicating mileage or hourmeter reading and date that oil filter was changed

C. Sealed-cartridge type oil filter

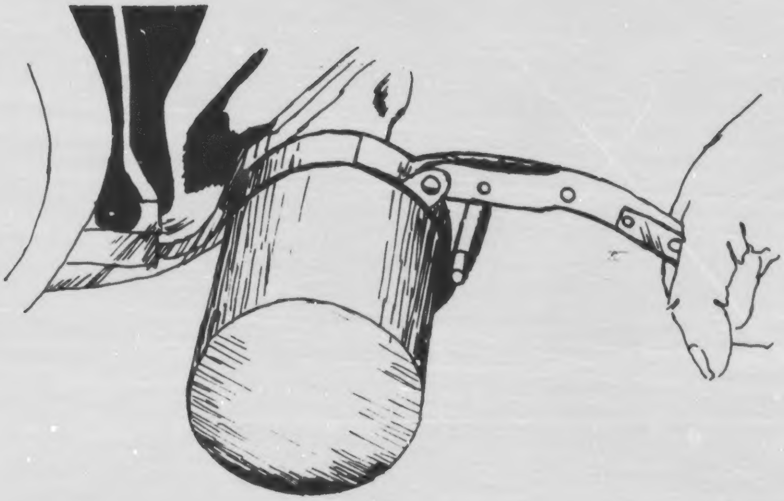
1. Support front of vehicle on jack stands if required

2. Place drain pan under oil filter

3. Remove oil filter cartridge with suitable tool (Figure 41)

   (NOTE: Turn counterclockwise to remove.)

FIGURE 41

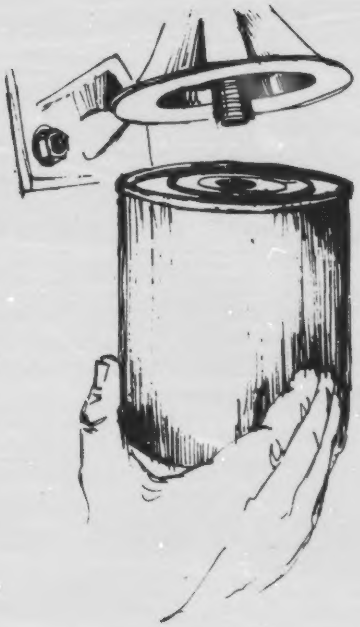


4. Lubricate the sealing gasket on the new oil filter cartridge with clean motor oil if required

JOB SHEET #11

5. Replace oil filter cartridge; tighten to manufacturer's instructions (Figure 42)

FIGURE 42



(NOTE: Usually, hand tightening is sufficient.)

6. Remove jack stands and lower vehicle to floor
7. Add oil or refill crankcase as required
8. Start engine
9. Check for leaks
10. Shut off engine
11. Check oil level on dipstick

    (NOTE: Add oil if required. Do not overfill.)

12. Fill out service chart, indicating mileage or hourmeter reading and date that oil filter was changed

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PRINCIPLES OF ENGINE OPERATION
UNIT VI

TEST

NAME________________________________ SCORE ______________

1. Match terms associated with principles of engine operation to their correct definitions. Write the correct numbers in the blanks. Terms and definitions are continued on the next page.

_____a. Reduction in volume of gases trapped in cylinder by upward motion of piston

_____b. Series of events that repeats itself in a regular sequence

_____c. Distance piston moves when traveling from TDC to BDC

_____d. Top dead center

_____e. Bottom dead center

_____f. Ratio of whole cylinder volume to clearance volume

_____g. Total space between piston at BDC and cylinder head

_____h. Total space between piston at TDC and cylinder head

_____i. Liquid that circulates through cooling system to transfer engine heat

_____j. Heat-controlled valve in the cooling system used to regulate the flow of coolant between cylinder block and radiator

_____k. Radiator cap which increases pressure within cooling system several psi, allowing coolant to circulate at higher temperatures without evaporation or surge loss

_____l. Pounds per square inch

_____m. Device that atomizes fuel and sprays it into combustion chamber

_____n. To reduce a liquid to a fine spray

1. TDC
2. Volume
3. psi
4. Compression
5. Thermostat
6. BDC
7. Atomize
8. Clearance volume
9. Cycle
10. Pressure cap
11. Compression ratio
12. Coolant
13. Injection nozzle
14. Stroke

TEST

_____o. Number of degrees of distributor cam rotation that ignition points are closed

_____p. Measure of ability of an oil to resist flowing

_____q. Abbreivation for Society of Automotive Engineers; classification of motor, transmission, or differential lubricants to indicate viscosities standardized by this society

_____r. Disc or offset section (of a shaft) used to convert rotary motion to reciprocating motion (cam)

_____s. Substance added to cooling system to lower its freezing point

_____t. Potential difference or electromotive force measured in volts

_____u. Flow of electric charge

_____v. Property of a conductor by which it opposes the flow of an electric current and generates heat in conducting material

_____w. Standard unit for measuring the strength of an electric current; rate of flow or charge in a conducting medium

_____x. Wire, cable, or other medium suitable for carrying electric current

_____y. Method of pushing air out of cylinders during the exhaust stroke on two-cycle engines

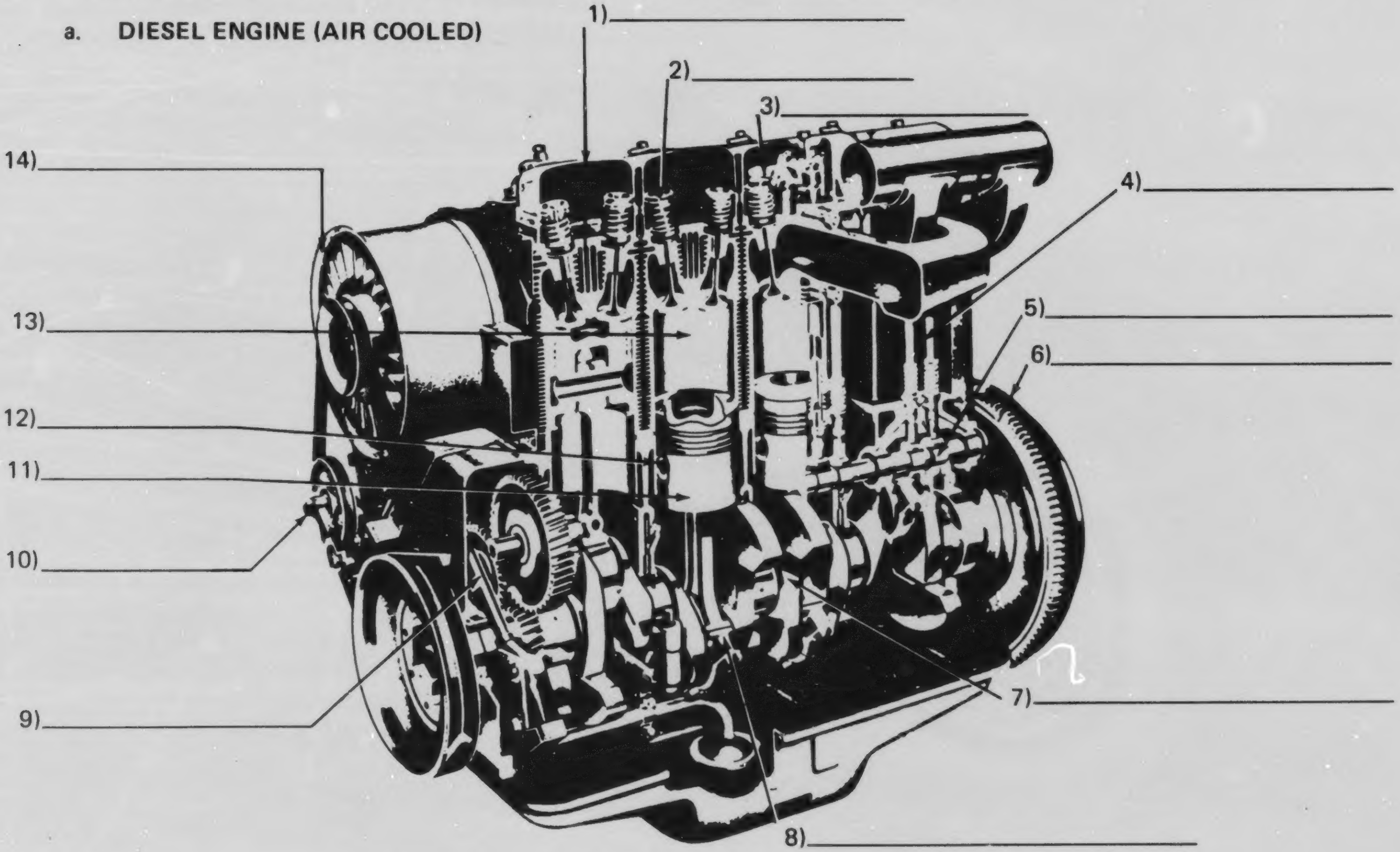
_____z. The unit of force in the mks (meter-kilogram-second) system

15. SAE
16. Dwell
17. Viscosity
18. Eccentric
19. Current
20. Newton
21. Antifreeze
22. Conductor
23. Resistance
24. Voltage
25. Ampere
26. Scavenge

TEST

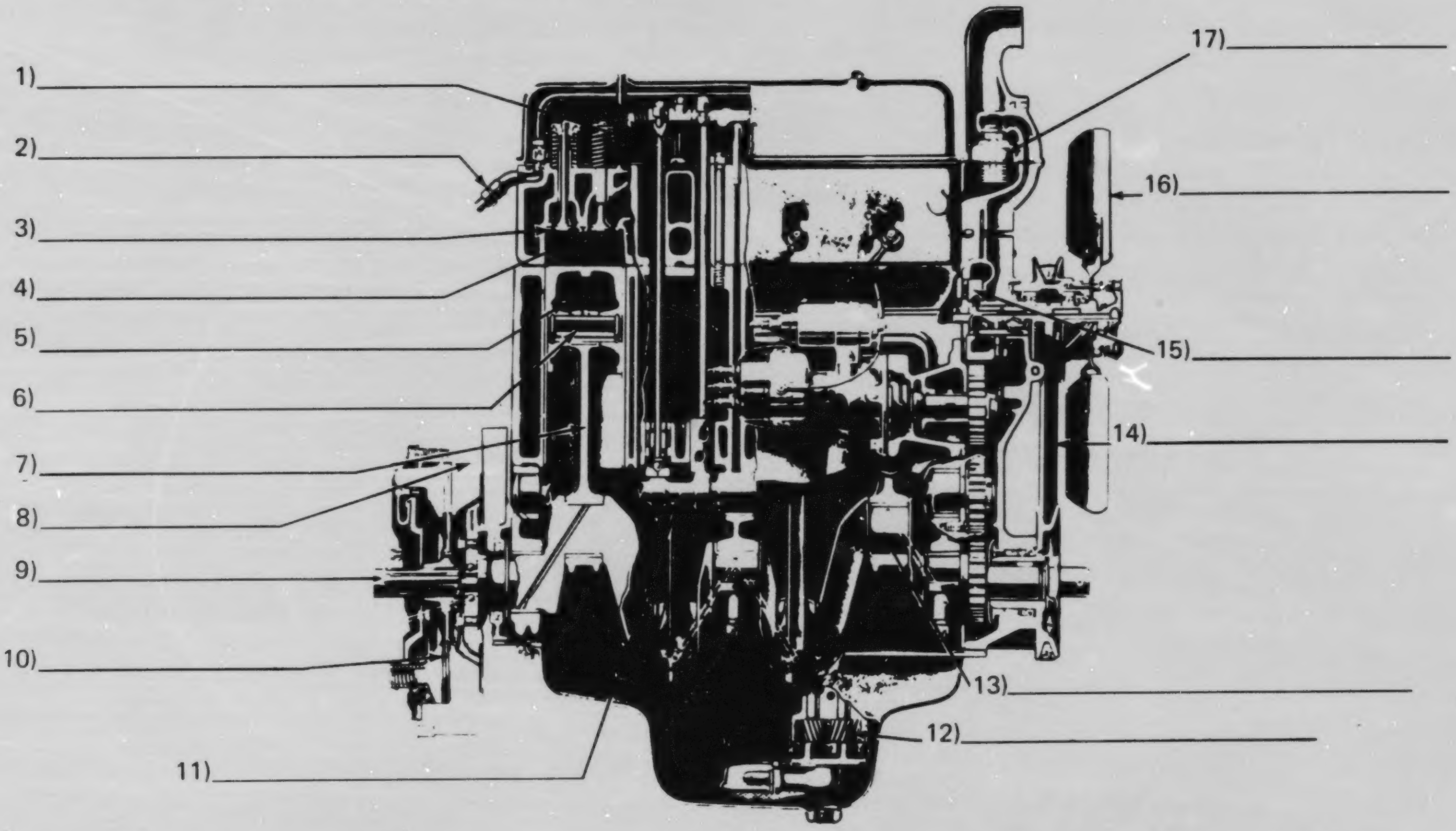
2. Label basic parts of diesel and gasoline engines. Write the correct names in the blanks.

a. DIESEL ENGINE (AIR COOLED)


1) ____________________
2) ____________________
3) ____________________
4) ____________________
5) ____________________
6) ____________________
7) ____________________
8) ____________________
9) ____________________
10) ____________________
11) ____________________
12) ____________________
13) ____________________
14) ____________________

TEST

b. GASOLINE ENGINE (INDUSTRIAL)


1)
2)
3)
4)
5)
6)
7)
8)
9)
10)
11)
12)
13)
14)
15)
16)
17)

TEST

3. Arrange in order the strokes in a two-stroke or four-stroke engine. Write "1" in the blank before the first procedure, "2" in the blank before the second, and so on.

______a. Power (ignition)

______b. Intake

______c. Exhaust

______d. Compression

4. List basic differences between a gasoline engine and a diesel engine.

a. Gasoline

1) ____

2) ____

3) ____

4) ____

b. Diesel

1) ____

2) ____

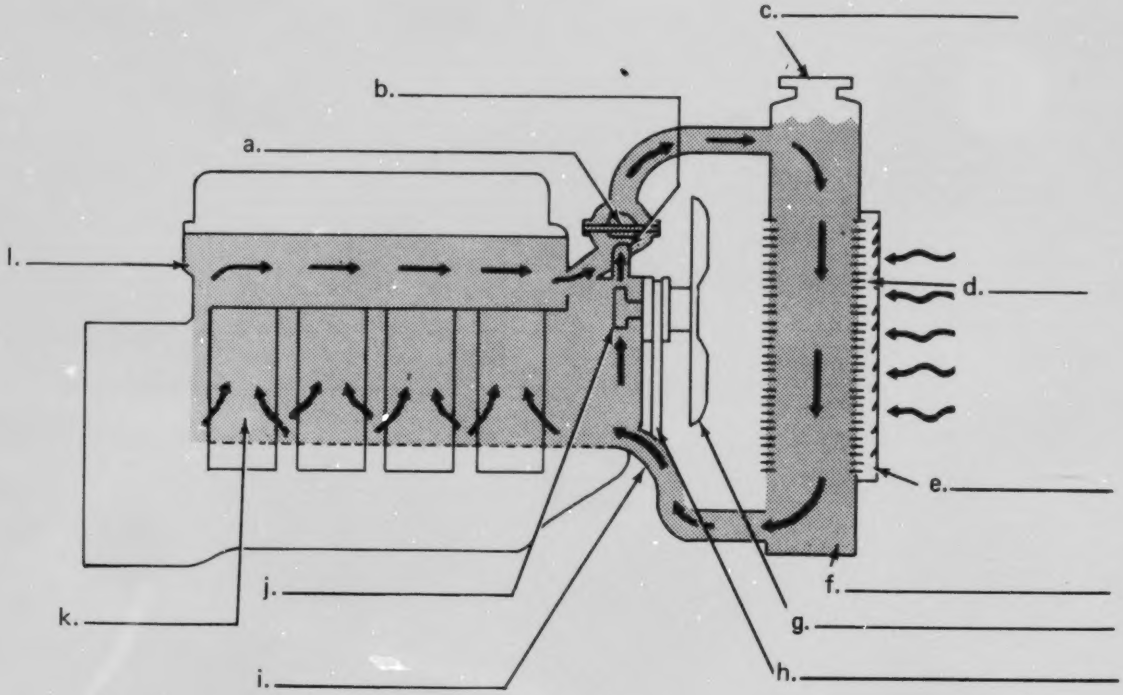
3) ____

4) ____

TEST

5. Identify components of the cooling system illustrated below. Write the correct names in the blanks.

- Pressure cap
- Thermostat
- Engine water jacket
- Bypass
- Radiator
- Fan belt
- Coolant
- Air flow
- Fan (reversible in diesel system)
- Water pump
- Radiator hose
- Shutters (diesel engine)



TEST

6. Match types of cooling systems to their correct uses. Write the correct numbers in the blanks.

_____a. Uses a fan 1. Air

_____b. Uses circulating coolant 2. Liquid

7. Select from the following list requirements of a good coolant. Write an "X" in the blank before each correct answer.

_____a. Conductor of electricity

_____b. Nonconductor of heat

_____c. Chemically stable

_____d. Causes freezing

_____e. Flows readily at all temperatures

_____f. Resists foaming

_____g. Causes rust and corrosion

_____h. Lubricates radiator

8. Describe operation of thermostat when engine is cold and when engine is at operating temperature.

a. When engine is cold-- ____

____

b. When engine is at operating temperature-- ______________________________

____

9. Distinguish between components of fuel systems for gasoline and diesel engines. Write a "G" in the blanks before components of gasoline fuel system, a "D" in the blanks before components of diesel fuel systems, and a "GD" in the blanks before components pertaining to both.

_____a. Fuel filter

_____b. Carburetor

_____c. Fuel tank

_____d. Injection pump (distributor type) ______e. Fuel pump (gasoline engine) or fuel transfer pump (diesel engine)

______f. Air cleaner

______g. Fuel lines

______h. Injection nozzles

10. Distinguish between functions of gasoline and diesel engine fuel systems. Write a "G" in the blank before functions of gasoline engine fuel system and a "D" in the blank before functions of diesel engine fuel system.

______a. Pumps fuel at low pressure from tank through filters to injection pump, where it times the fuel delivery, and measures and delivers fuel under pressure to injection nozzle, where it is atomized and sprayed into combustion chamber

______b. Pumps fuel from tank through filters into carburetor where it is mixed with air in proper proportion for a combustible mixture and then is delivered to cylinders

11. Distinguish among types of air cleaners. Write a "D" in the blank before dry element, a "V" in the blank before viscous impingement, and an "O" in the blank before oil bath.

______a. Cleans by passing air through a maze of metal wool, wire, or screens saturated with oil

______b. Cleans by directing air through a center tube into inner oil cup where direction of air flow is reversed, causing most dirt to become trapped by the oil and settle in the sump

______c. Cleans by passing air through a treated paper filter

12. Distinguish between direct current (DC) and alternating current (AC). Write "DC" in the blanks before direct current, and "AC" in the blanks before alternating current.

______a. Supplied by alternating current generator (alternator)

______b. Flows in one direction only

______c. Flows in one direction; then reverses and flows in the opposite direction

______d. Supplied by generator and battery (dry and wet cell)

13. State functions of a battery.

a. ____

b. ____

c. ____

TEST

14. Select from the following list processes by which a battery converts chemical energy into electrical energy. Write an "X" in the blank before each correct answer.

______a. More active metal will lose electrons and become positively charged

______b. Two similar minerals placed in acid will produce chemical action

______c. Two similar minerals placed in acid will not produce chemical action

______d. Less active metal will accumulate voltage and become positively charged

______e. Less active metal will accumulate electrons and become negatively charged

______f. Two dissimilar metals placed in acid solution will produce chemical action

15. Select from the following list safety rules pertaining to care and maintenance of batteries. Write an "X" in the blank before each correct answer.

______a. Avoid breathing fumes from battery

______b. Ground terminals to machine while servicing

______c. Do not allow electrolyte to come in contact with eyes, skin, clothing, or painted surfaces

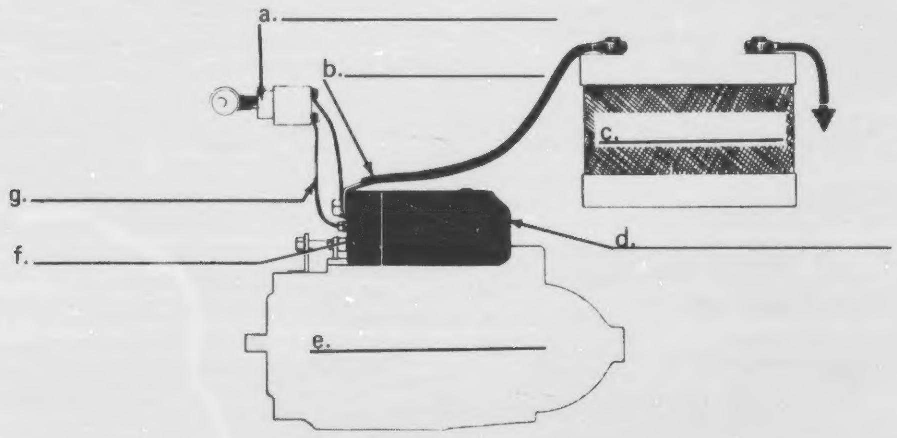
______d. Avoid shorting or grounding battery terminals during service

______e. Wear hard hats and safety shoes when servicing battery

______f. Flush battery immediately if electrolyte comes in contact with it

______g. Keep flames or sparks away from battery because gases given off by battery are very explosive

16. Label components of the starting system illustrated below. Write the correct names in the blanks.



TEST

17. Match major parts of a starting circuit to their correct functions. Write the correct numbers in the blanks.

_____a. Supplies energy for the circuit

_____b. Activates the circuit

_____c. Closes circuit to motor and engages motor drive with flywheel

_____d. Drives flywheel to start engine

1. Motor switch
2. Starting motor
3. Starter switch
4. Battery

18. List ten components of the ignition system.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

19. Arrange in order steps in operation of ignition system through one cycle. Write a "1" before the first step, a "2" before the second step, and so on.

_____a. This high-voltage surge is directed from the secondary windings of the coil through the distributor cap and rotor and on to the spark plug to ground

_____b. With the ignition switch on and the contact points closed, low-voltage current flows from the battery through the primary winding of the coil and through the contact points to ground

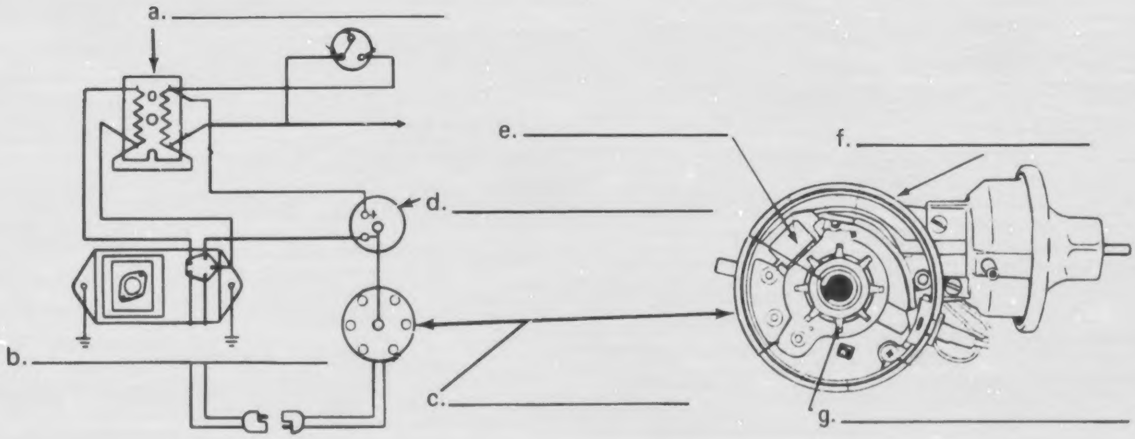
_____c. The flow of low-voltage current through the primary windings of the coil causes a magnetic field buildup

_____d. As the contact points open, current continues to flow across the point surfaces; the condenser attached to the points absorbs this flow of current

_____e. Stopping this flow of current causes the magnetic field of the coil primary windings to collapse across the secondary coil windings, causing a high-voltage surge

TEST

20. Label major components of the electronic ignition system illustrated below. Write the correct names in the blanks.



21. Match major components of an electronic ignition system to their correct functions. Write the correct numbers in the blanks.

_____a. Sends a small voltage pulse to control unit; this triggers switching transistor to stop current flow in the coil primary windings

_____b. Maintains constant primary current with variations in engine speed

_____c. Rotates with the distributor shaft, producing a voltage pulse in the magnetic pickup

_____d. Controls the flow of current in the primary windings of the ignition coil and maintains constant dwell

1. Armature or reluctor
2. Control unit
3. Magnetic pickup assembly
4. Dual ballast resistor

22. State three purposes of engine lubrication system.

a. ______________________________

b. ______________________________

c. ______________________________

TEST

23. Select from the following list characteristics of good engine oil. Write an "X" in the blank before each correct answer.

_____a. Resists corrosion and rusting

_____b. Produces sludge

_____c. Resists breakdown at high temperatures

_____d. Resists breakdown at low temperatures

_____e. Produces foam

_____f. Keeps a protective film on moving parts

_____g. Prevents carbon buildup

_____h. Produces oxidation

_____i. Flows easily at low temperatures

_____j. Resists breakdown after long use

24. List oil contaminants.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

25. Match oil additives to their correct functions. Write the correct numbers in the blanks. Functions are continued on the next page.

_____a. Helps prevent failure of alloy bearings from corrosive acids caused by combustion

_____b. Prevents acid, varnish, and sludge formation

_____c. Prevents rusting of metal parts during storage or downtime

_____d. Helps oil give top lubricating protection at both high and low temperatures

_____e. Prevents wax crystals from congealing in cold weather and forming clumps

1. Oxidation inhibitor
2. Detergent dispersant
3. Viscosity index improver
4. Foam inhibitor
5. Anti-corrosion additive
6. Anti-rust additive
7. Pour point depressant

TEST

_____f. Helps keep metal surfaces clean, and prevents deposit formation

_____g. Helps prevent air bubbles which would reduce lubrication

26. State three general rules for selecting engine oil.

    a. ____

    b. ____

    c. ____

(NOTE: Test question 27 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

27. Demonstrate the ability to

    a. Test antifreeze solution.

    b. Service an air cleaner.

    c. Clean and service a battery.

    d. Remove and replace a battery.

    e. Measure battery electrolyte with a hydrometer.

    f. Start an engine using a negative-ground booster battery.

    g. Use a 24-volt battery booster system to start a vehicle with a 12-volt system.

    h. Remove and replace contact points and condenser.

    i. Remove, service, and replace spark plugs.

    j. Change oil in an engine.

    k. Change an oil filter.

PRINCIPLES OF ENGINE OPERATION
UNIT VI

ANSWERS TO TEST

1. a. 4
   b. 9
   c. 14
   d. 1
   e. 6
   f. 11
   g. 2
   h. 8
   i. 12
   j. 5
   k. 10
   l. 3
   m. 13
   n. 7
   o. 16
   p. 17
   q. 15
   r. 18
   s. 21
   t. 24
   u. 19
   v. 23
   w. 25
   x. 22
   y. 26
   z. 20

2. a. **DIESEL ENGINE (AIR COOLED)**
   1) Cylinder head
   2) Exhaust valve
   3) Rocker arm
   4) Push rods
   5) Camshaft
   6) Flywheel
   7) Crankshaft
   8) Connecting rod
   9) Timing gears
   10) V-belt idler
   11) Piston
   12) Wrist pin
   13) Combustion chamber
   14) Cooling air blower

   b. **GASOLINE ENGINE (INDUSTRIAL)**
   1) Push rods
   2) Crankcase breather
   3) Exhaust valve
   4) Intake valve
   5) Piston
   6) Piston pin
   7) Connecting rod
   8) Flywheel
   9) Clutch pilot shaft
   10) Clutch
   11) Camshaft and cams
   12) Gear oil pump
   13) Crankshaft
   14) Fan belt

ANSWERS TO TEST

15) Water pump

16) Cooling fan

17) Thermostat

3. a. 3

   b. 1

   c. 4

   d. 2

4. a. Gasoline

      1) Ignition by electrical spark

      2) Takes fresh air and fuel through carburetor, and then to combustion chamber

      3) Low compression ratio (7-12:1)

      4) Burns gasoline

   b. Diesel

      1) Ignition by compression

      2) Takes fresh air directly to combustion chamber

      3) High compression ratio (16-22:1)

      4) Burns low-grade fuel oil

5. a. Thermostat

   b. Bypass

   c. Pressure cap

   d. Air flow

   e. Shutters (diesel engine)

   f. Radiator

   g. Fan (reversible in diesel system)

   h. Fan belt

   i. Radiator hose

   j. Water pump

   k. Coolant

   l. Engine water jacket

6. a. 1

   b. 2

ANSWERS TO TEST

7. c, e, f

8. Description should include the following

   a. When engine is cold--Thermostat shuts off flow of coolant from engine to radiator to allow quicker engine warm-up

   b. When engine is at operating temperature--Thermostat is open and allows coolant to circulate through system

9. a. GD

   b. G

   c. GD

   d. D

   e. GD

   f. G

   g. GD

   h. D

10. a. D

    b. G

11. a. V

    b. O

    c. D

12. a. AC

    b. DC

    c. AC

    d. DC

13. a. Supplies current for cranking engine

    b. Supplies current when demand exceeds output of charging system

    c. Stabilizes voltage in system during operation

14. a, e, f

15. a, c, d, g

16. a. Key switch

    b. Battery cable

    c. Battery

    d. Solenoid

    e. Starter

    f. Starter switch

    g. Small-gauge switch wire

ANSWERS TO TEST

17. a. 4
    b. 3
    c. 1
    d. 2

18. Answer should include any ten of the following
    a. Battery
    b. Ignition switch
    c. Primary resistance unit
    d. Ignition coil
    e. Contact points (breaker points)
    f. Condenser
    g. Distributor
    h. Breaker cam
    i. Spark advance mechanism
    j. Rotor
    k. Distributor cap
    l. Spark plug
    m. Primary ignition wire
    n. Secondary ignition wire (high-voltage cable)

19. a. 5
    b. 1
    c. 2
    d. 3
    e. 4

20. a. Dual ballast resistor
    b. Control unit
    c. Distributor
    d. Ignition coil
    e. Magnetic pickup assembly
    f. Distributor housing
    g. Armature or reluctor

21. a. 3
    b. 4
    c. 1
    d. 2

ANSWERS TO TEST

22. Answer should include any three of the following

    a. Lubricates moving parts to minimize friction

    b. Acts as cooling agent to remove heat from moving parts

    c. Forms a seal between piston rings and cylinder walls

    d. Keeps parts clean

    e. Absorbs shock between bearings and other parts

23. a, c, f, g, i, j

24. a. Foreign particles

    b. Water

    c. Antifreeze

    d. Fuel

    e. Oxidation

25. a. 5

    b. 1

    c. 6

    d. 3

    e. 7

    f. 2

    g. 4

26. Answer should include any three of the following

    a. Use brands of proper service rating recommended by manufacturer

    b. Select brands that have been service tested

    c. Never mix oils with different SAE or viscosity ratings

    d. Use oil of proper viscosity for average temperature at which the vehicle will operate

27. Performance skills evaluated to the satisfaction of the instructor

PREVENTIVE MAINTENANCE
UNIT VII

UNIT OBJECTIVE

After completing this unit, the student should be able to perform preventive maintenance on equipment and complete appropriate maintenance records. This knowledge will be shown by completing assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with preventive maintenance to their correct definitions.
2. Select from a list factors that should be included in preventive maintenance.
3. Select from a list items to check in a visual inspection.
4. Identify items that should be checked on a daily (or shift) checklist.
5. Select from a list types of preventive maintenance inspections.
6. Label safe service positions.
7. Identify types of grease guns and grease fittings.
8. Label main parts of the cooling system.
9. Complete daily (or shift) preventive maintenance inspection.
10. Complete a 50-hour preventive maintenance inspection.
11. Complete a 250-hour preventive maintenance inspection.
12. Complete a 1000-hour preventive maintenance inspection.
13. Demonstrate the ability to
    a. Lubricate a truck.
    b. Lubricate a wheel loader.

PREVENTIVE MAINTENANCE
UNIT VII

SUGGESTED ACTIVITIES

I. Suggested activities

   A. Order materials to supplement unit--Film--*Dirt. . .The Quiet Thief.* 21 minutes, Modern Talking Picture Service, Inc., n.d. Available from Caterpillar Film Library, 1687 Elmhurst Road, Elk Grove Village, Illinois 60007.

      (NOTE: Lubrication is a key part of the defense against dust, grit, and corrosive chemicals that can sideline expensive machinery. An experienced service specialist takes you "backstage" on an earthmoving job for a close look at fuel handling and lubrication procedures. When ordering, specify film #3460.)

   B. Provide students with objective sheet.

   C. Provide students with information, assignment, and job sheets.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

      (NOTE: Assignment sheets include activities involving equipment and materials.)

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Caution students as to use and care of tools.

   H. Caution students as to safety and service position of machines.

   I. Procure daily record books for each student.

   J. Reproduce or obtain monthly record sheets for students to fill out.

   K. Use manufacturer's maintenance guides for particular equipment when performing preventive maintenance inspections.

   L. Give test.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

SUGGESTED ACTIVITIES

D. Assignment sheets

1. Assignment Sheet #1--Complete A Daily (or Shift) Preventive Maintenance Inspection

2. Assignment Sheet #2--Complete a 50-Hour Preventive Maintenance Inspection

3. Assignment Sheet #3--Complete a 250-Hour Preventive Maintenance Inspection

4. Assignment Sheet #4--Complete a 1000-Hour Preventive Maintenance Inspection

E. Answers to assignment sheets

F. Job sheets

1. Job Sheet #1--Lubricate a Truck

2. Job Sheet #2--Lubricate a Wheel Loader

G. Test

H. Answers to test

III. Unit references

A. *Clark Operator's Manual No. 3232, 75B Michigan Tractor Shovel.* Benton Harbor, Michigan: Clark Equipment Company, n.d.

B. Hendrix, Laborn J. "Bud." *Heavy Equipment Operator, Volume I.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/ Curriculum and Instructional Materials Center and Associated General Contractors of America, 1981.

C. Nichols, Herbert L., Jr. *Heavy Equipment Repair.* Greenwich, Connecticut: North Castle Books, 1969.

D. Nichols, Herbert L., Jr. *Moving the Earth.* Greenwich, Connecticut: North Castle Books, 1976.

E. *Operator's Instructions 325H.* South Milwaukee, Wisconsin: Bucyrus-Erie Company, 1978.

F. *Preventive Maintenance Guide for Tractor Shovels.* Benton Harbor, Michigan: Clark Equipment Company, n.d.

PREVENTIVE MAINTENANCE
UNIT VII

INFORMATION SHEET

I. Terms and definitions

A. Alemite®--Type of grease

B. Drag link--Four-bar linkage in which both cranks traverse full circles; the fixed member must be the shortest link

C. Grease--Thick lubricant

D. Honing stone--Device containing several oblong abrasive stones arranged in a circular pattern; used to remove small amounts of material from cylindrical surfaces

E. Kilopascal (kPa)--Metric unit of pressure similar to psi (pounds per square inch)

F. Lubricant--Substance that reduces friction between surfaces

G. Packing gland--Device preventing leakage at a machine joint

H. Preventive maintenance (PM)--Taking care of equipment systematically to reduce repairs

I. SAE number--Classification of motor, transmission, and differential lubricants to indicate viscosities standardized by the Society of Automotive Engineers

(NOTE: SAE numbers do not connote quality of lubricant.)

J. Sediment--Solid material that is not in solution and either is distributed through the liquid or has settled out of the liquid

K. Sender unit--Operating safety feature for gauges

II. Factors that should be included in preventive maintenance (Assignment Sheets #1-#4)

A. Inspections

B. Scheduled service

C. Scheduled lubrication

D. Frequent cleaning of equipment

E. Adjustments

F. Prompt correction of defects

G. Complete and accurate records

INFORMATION SHEET

III. Items to check in a visual inspection

(NOTE: Visual inspection means walking completely around machine, looking for and recording any damage or defects.)

- A. Leaks or streaks that may indicate leaks

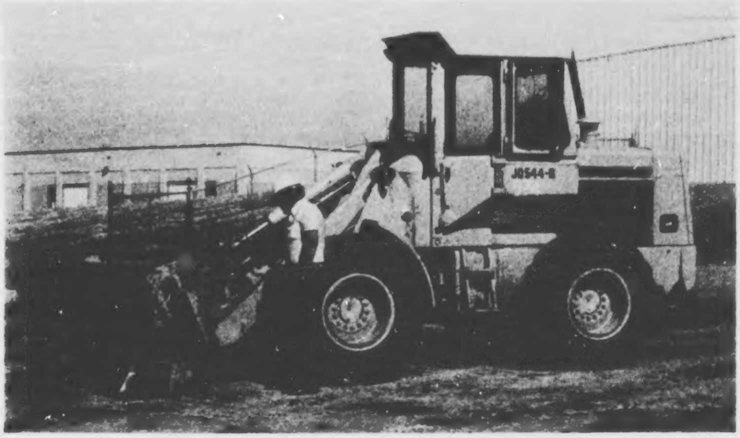
  (NOTE: Watch for leaks on ground, on hoses, and on inside of tires.)

- B. Damage and condition of tires and/or tracks and undercarriage
- C. Engine damage
- D. Lights, for damage
- E. Radiator
- F. Switches and controls
- G. Levers, rods, caps, fittings, cylinder, and rods
- H. Dirt accumulation that could be harmful to machine
- I. Fluid levels on all components
- J. Condition of windshield wipers (when applicable)
- K. Conditions of attachments or accessories

IV. Items on daily (or shift) checklist (Figures 1-12; Assignment Sheet #1)

- A. Visual inspection

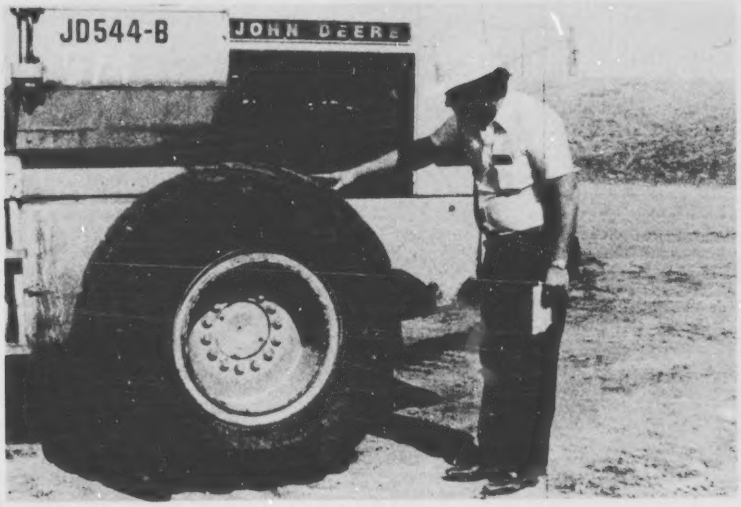
FIGURE 1



INFORMATION SHEET

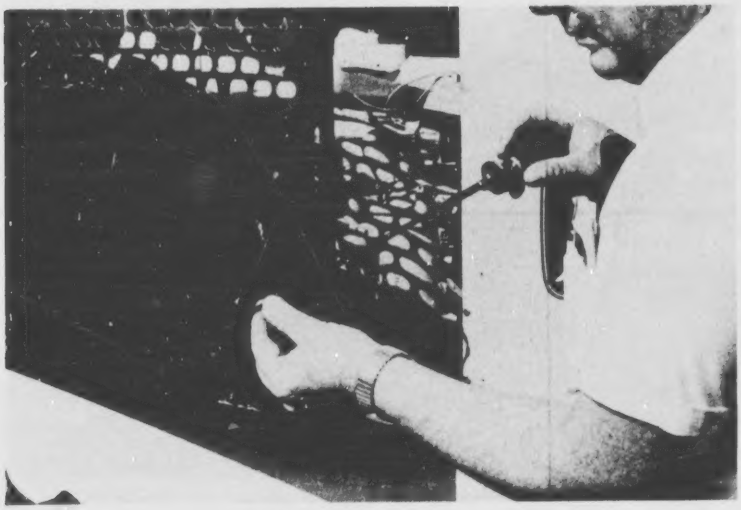
B. Tires and tire pressure

FIGURE 2


JD544-B
JOHN DEERE

C. Engine oil level

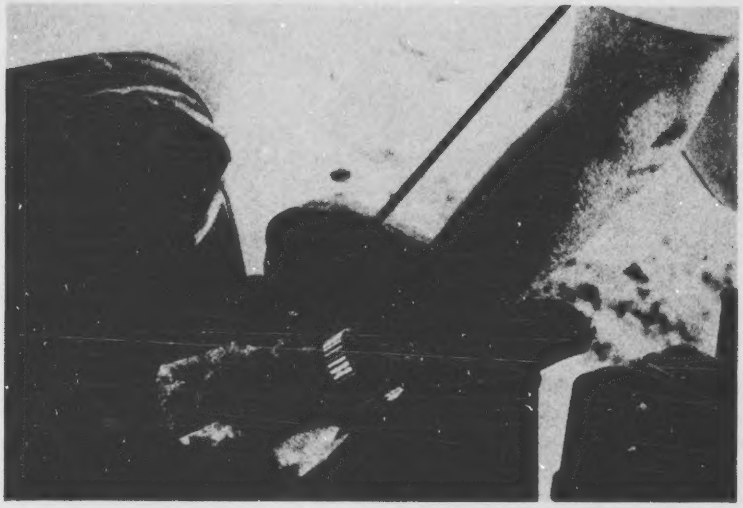
FIGURE 3



INFORMATION SHEET

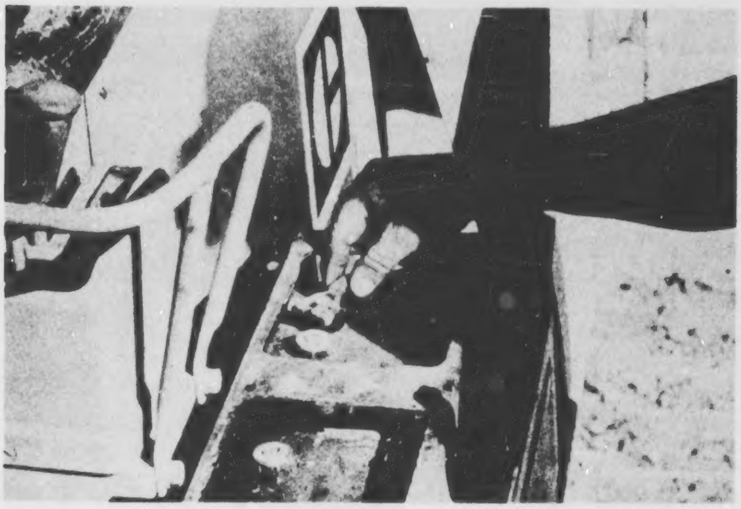
D. Transmission fluid level

FIGURE 4



E. Battery electrolyte level; battery connections

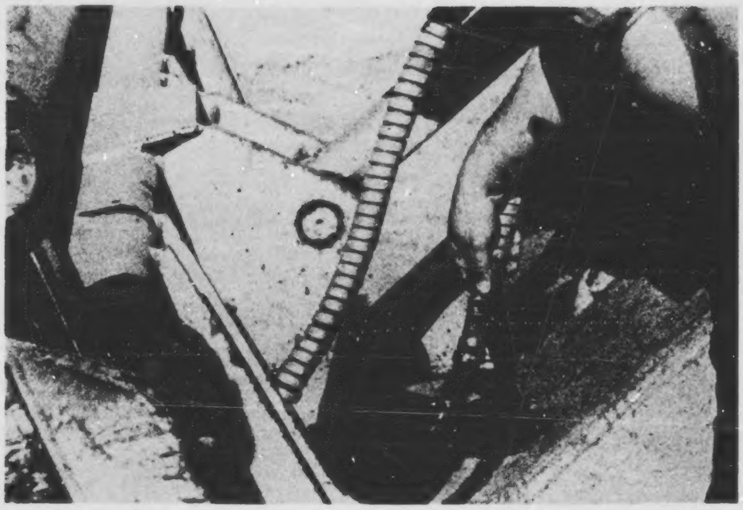
FIGURE 5



INFORMATION SHEET

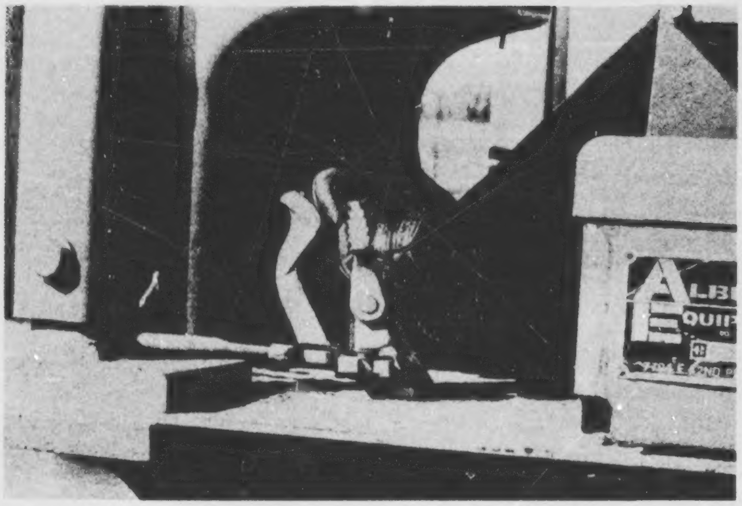
F. Hydraulic system

FIGURE 6



G. Brakes (testing with foot pedal)

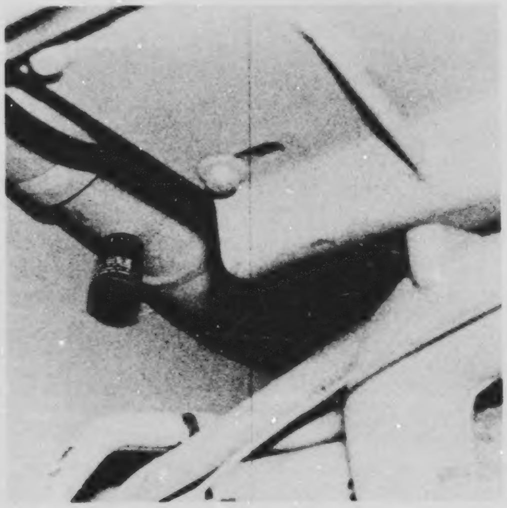
FIGURE 7



INFORMATION SHEET

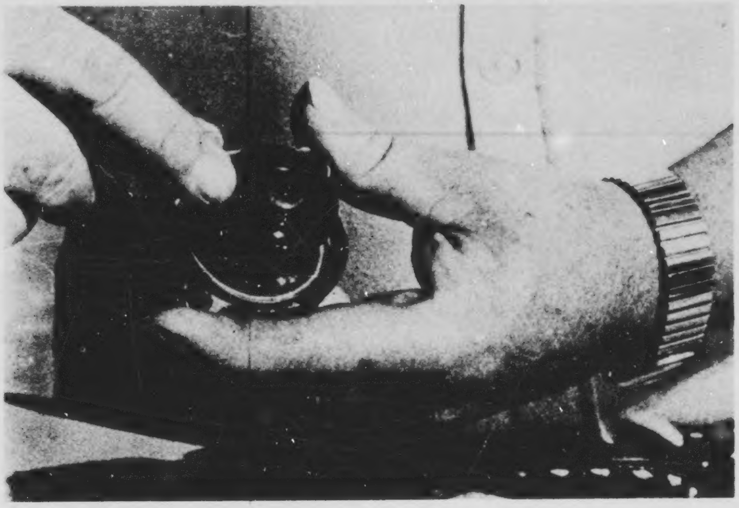
H. Air cleaner indicator

FIGURE 8



I. Cooling system level and pressure cap

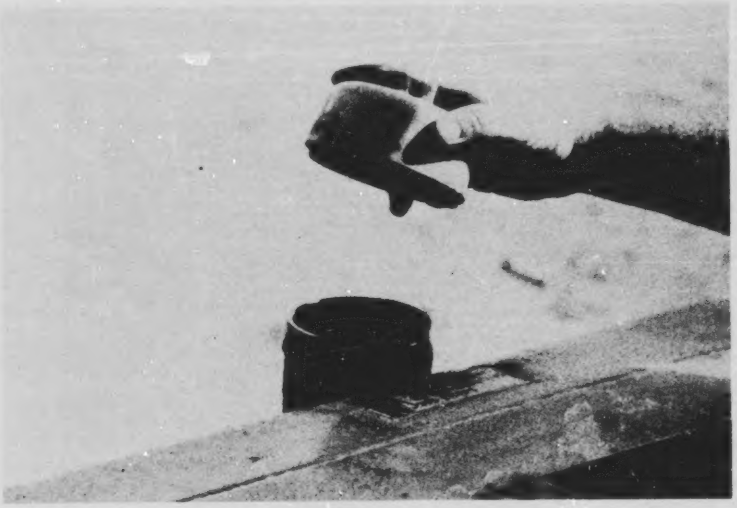
FIGURE 9



INFORMATION SHEET

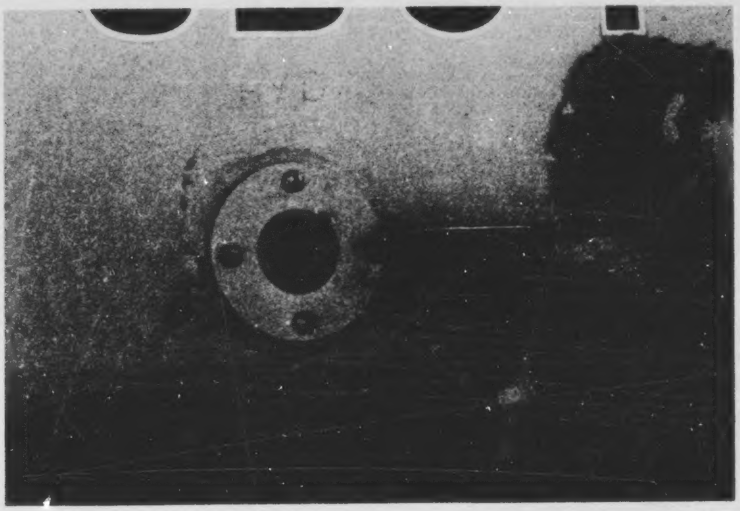
J. Fuel system and supply

FIGURE 10



K. Hydraulic fluid level on sight glass and/or dipstick

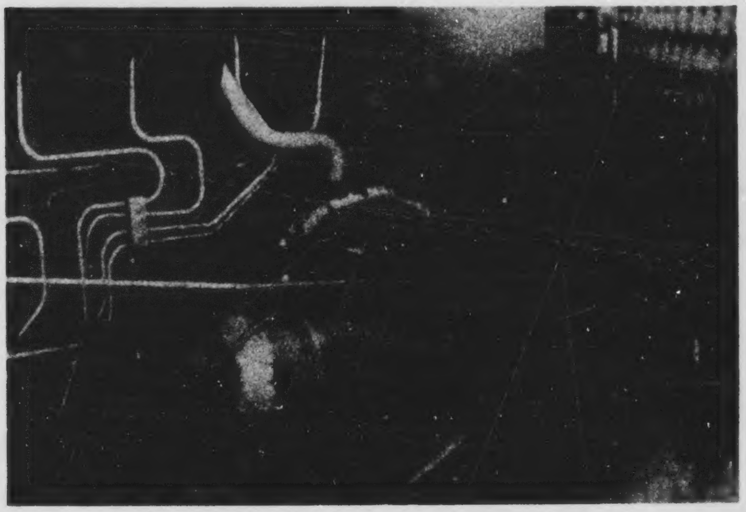
FIGURE 11



INFORMATION SHEET

L. Insulation and connections on wires in electrical system

FIGURE 12



V. Types of preventive maintenance inspections (Assignment Sheets #1-#4)

A. Visual

B. Daily

C. 50-hour

D. 250-hour

E. 1000-Hour

(NOTE: Follow departmental recommendations for prescribed inspections.)

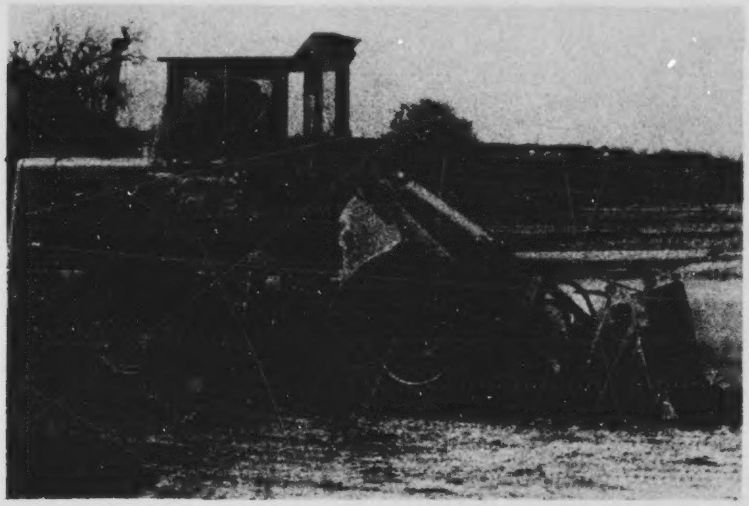
INFORMATION SHEET

VI. Safe service positions (Figures 13-19)

(NOTE: The following positions are for a wheel loader.)

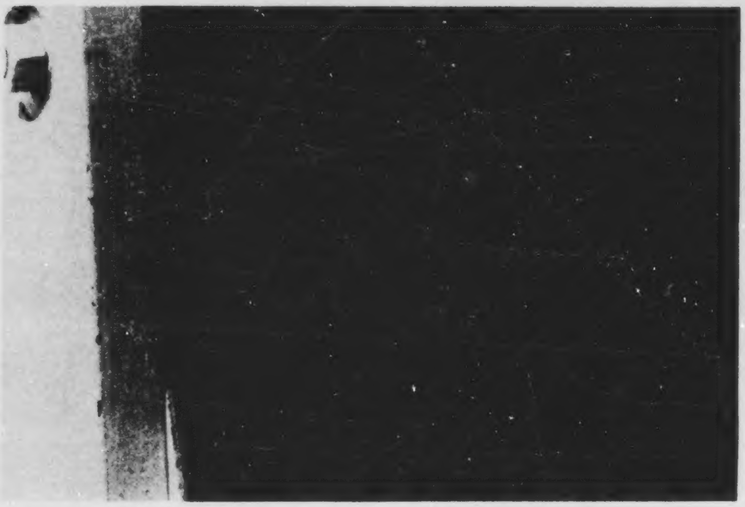
A. Attachment on ground

FIGURE 13



B. Parking brake applied

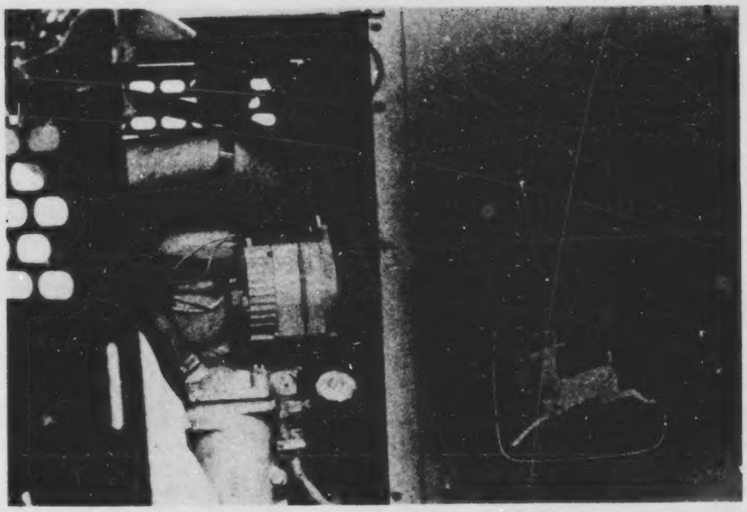
FIGURE 14



INFORMATION SHEET

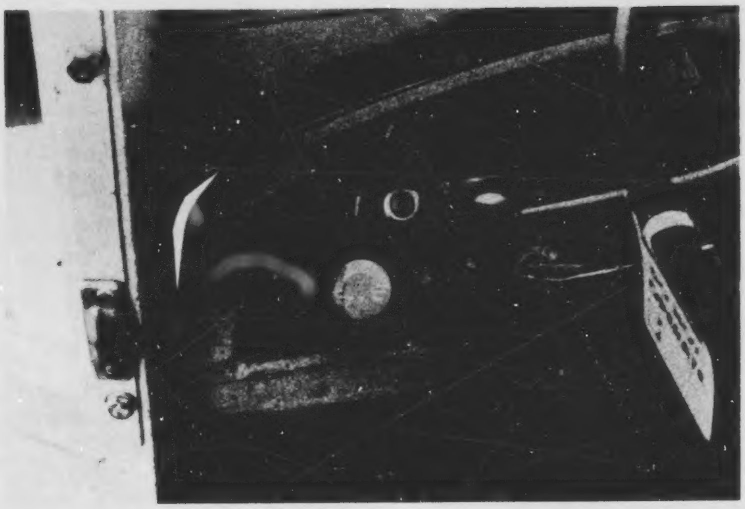
C. Engine stopped

FIGURE 15



D. Ignition key removed

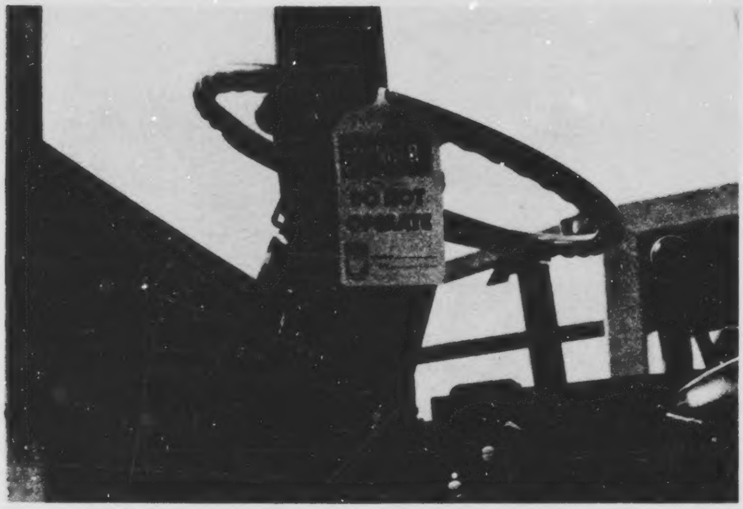
FIGURE 16



INFORMATION SHEET

E. Steering wheel tagged

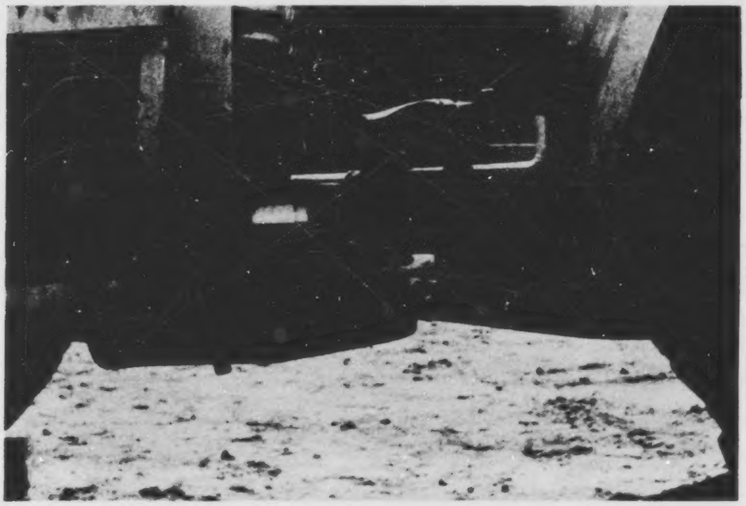
FIGURE 17



F. Safety link connected

(NOTE: This service position pertains to articulated loader only.)

FIGURE 18



INFORMATION SHEET

G. Wheels blocked

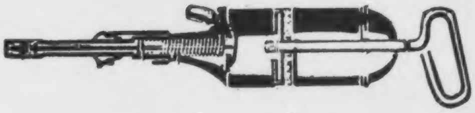
FIGURE 19

VII. Types of grease guns and grease fittings (Job Sheets #1 and #2)

A. Grease guns (Figures 20-28)

1. Push-type hand gun

FIGURE 20



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INFORMATION SHEET

2. Lever-type handguns

FIGURE 21

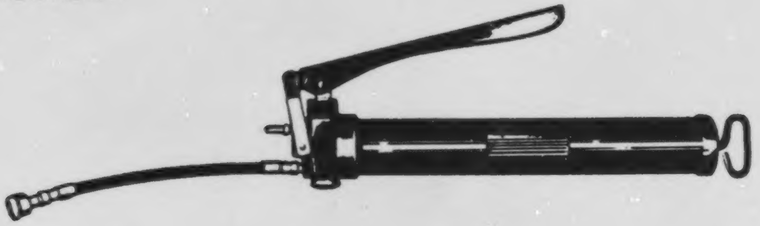
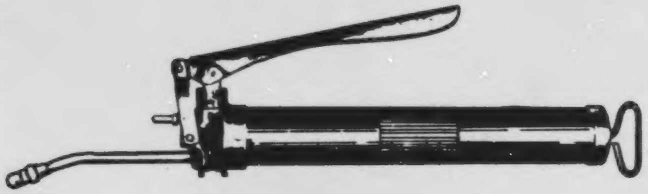
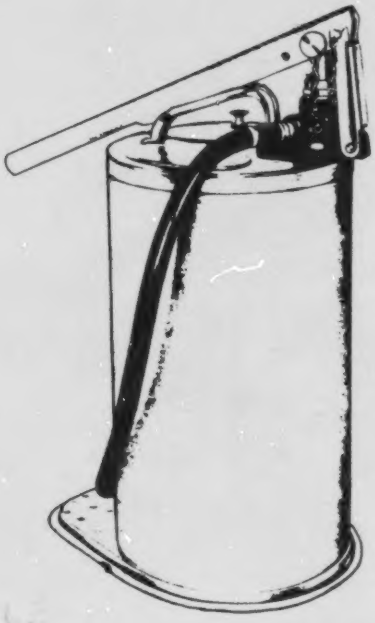


FIGURE 22



3. Volume-pressure bucket pump

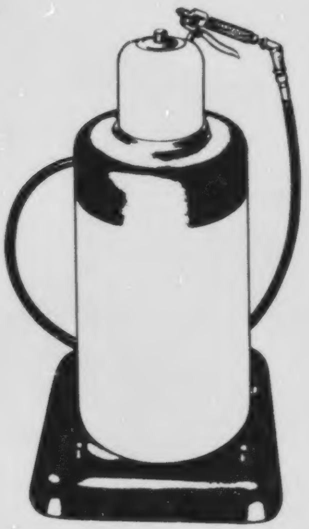
FIGURE 23



INFORMATION SHEET

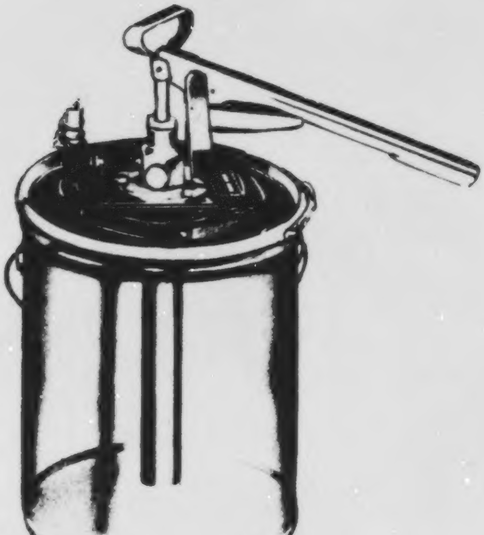
4. Portable air-operated pump

FIGURE 24



5. Pail-cover pump

FIGURE 25



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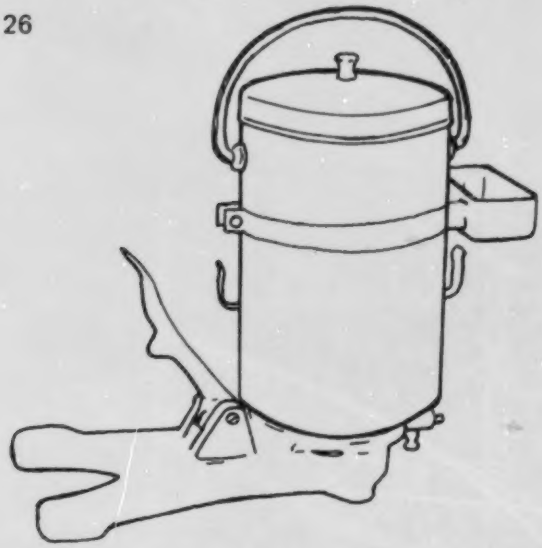
INFORMATION SHEET

6. Foot-lever bucket pump

FIGURE 26



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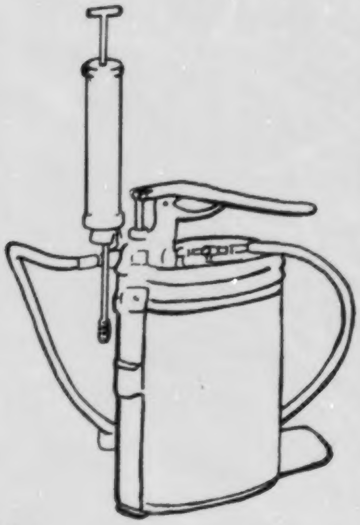
7. Handgun loader

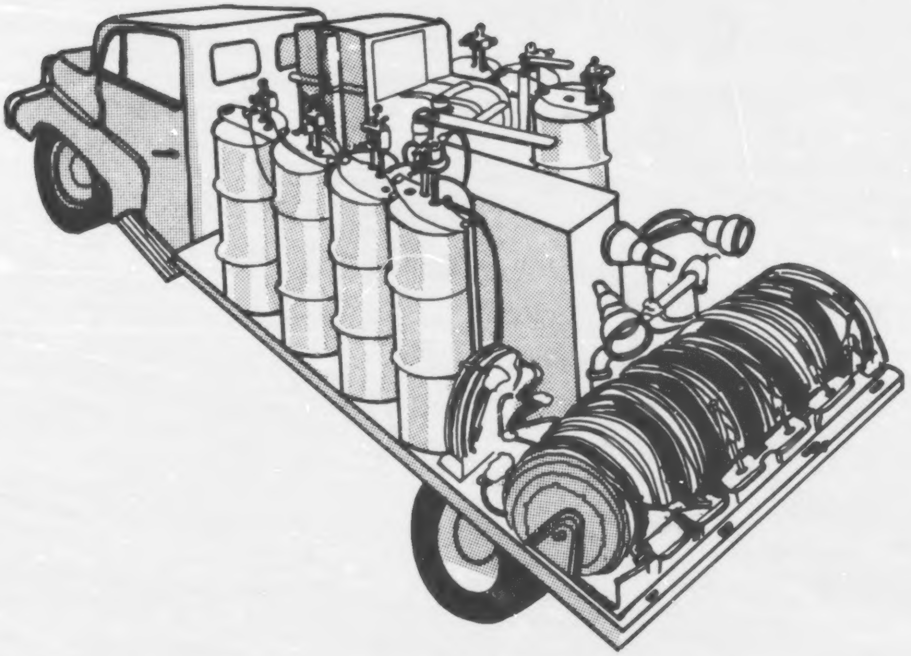
FIGURE 27



INFORMATION SHEET

8. Grease truck

FIGURE 28



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INFORMATION SHEET

B. Grease fittings (Figures 29-36)

1. Hydraulic fittings

FIGURE 29

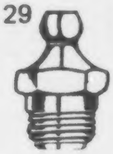
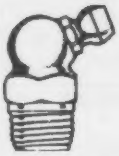
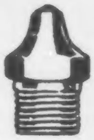


FIGURE 30



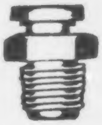
2. Zerk fitting

FIGURE 31



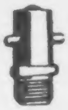
3. Buttonhead fitting (takes special attachment)

FIGURE 32



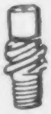
4. Alemite® fitting (takes special attachment)

FIGURE 33



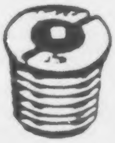
5. Dot fitting (takes special attachment)

FIGURE 34



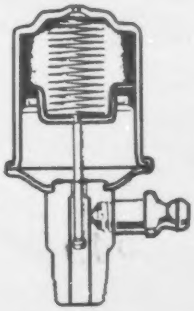
6. Flush fitting (takes special attachment)

FIGURE 35



7. Reservoir fitting

FIGURE 36



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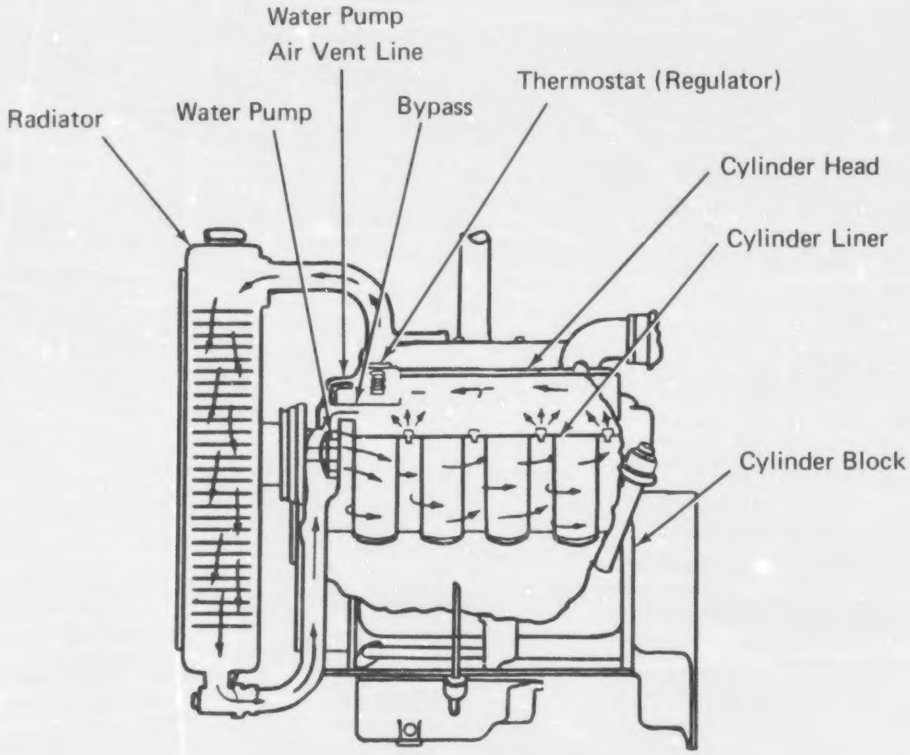
INFORMATION SHEET

VIII. Main parts of the cooling system (Figure 37)

(NOTE: The engine cooling system removes heat through the radiator from the cylinder walls and combustion chambers. Only part of the energy in fuel is converted to usable energy in an engine; the rest is turned into heat. Most of the heat goes out the exhaust; but if it is not removed, enough remains to destroy the engine completely in a few minutes.)

FIGURE 37


Water Pump
Air Vent Line
Thermostat (Regulator)
Radiator
Water Pump
Bypass
Cylinder Head
Cylinder Liner
Cylinder Block

PREVENTIVE MAINTENANCE
UNIT VII

ASSIGNMENT SHEET #1--COMPLETE DAILY (OR SHIFT) PREVENTIVE MAINTENANCE INSPECTION

NAME ______________________ SCORE ______________

Daily (or shift) inspection is the most basic element of preventive maintenance. Complete the daily inspection as outlined below and fill out the report sheet. Initial it, and turn it in to your instructor after you have completed the inspection.

Check (✓), Repair (R), or Adjust (A).

A. VISUAL INSPECTION

1. Walk entirely around machine, looking for leaks or streaks. . . . . ☐
2. Look for damage to tires, engine, lights, and radiator . . . . ☐
3. Examine switches, controls, levers, rods, caps, fittings . . . . ☐
4. Remove any dirt or material large enough to be a hazard . . . . ☐

(NOTE: Do not attempt to operate a damaged machine.)

B. TIRES AND UNDERCARRIAGES

1. Check tire pressure; inspect tread condition . . . . ☐
2. Examine valves and reinstall caps . . . . ☐

(NOTE: Do not operate machine with a defective tire.)

C. ENGINE (Refer to engine manufacturer's manual)

1. Check oil level, noticing dirt or grit, and leaks. . . . . ☐
2. Drain and refill crankcase if required. . . . . ☐

D. TRANSMISSION AND TORQUE CONVERTER

1. Check for leaks . . . . ☐
2. Check oil level, noting condition of oil . . . . ☐
3. Drain and change oil if required . . . . ☐

E. LUBRICATION--Lubricate all daily (or shift) fittings, following instructions on lubrication chart . . . . ☐

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ASSIGNMENT SHEET #1

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

Used with permission of Clark Equipment Company.

ASSIGNMENT SHEET #1

F. **CENTRAL LUBRICATION SYSTEM** (if applicable)

1. Refill grease barrel. ☐
2. Check lines, manual operation, and fittings. ☐

   (NOTE: If barrel has been allowed to run dry, pump grease through system with pressure gun to remove all air at each lube port.)

G. **BRAKES**--Check operation of service (wheel) brakes, parking brake, and safety brake system ☐

(NOTE: If brake lines leak, or if system components need repair or replacement, do not operate machine until condition has been corrected.)

H. **AIR CLEANER INDICATOR**

1. Service elements when indicator shows red ☐
2. Clean or replace elements as required ☐

   (NOTE: It may be necessary to do this more than once a day.)

I. **COOLING SYSTEM**

1. Check coolant level; refill if required (note quantity) ☐
2. Check anti-freeze protection, if used. ☐

J. **FUEL SYSTEM**

1. Examine all "quick start" connections for leaks (during cold weather) ☐
2. Check fuel tank level (note quantity) ☐

K. **HYDRAULIC SYSTEM**--Refer to manufacturer's recommendations ☐

L. **AIR TANKS**

1. If machine does not have air dryer, drain off moisture ☐
2. Replace air dryer dessicant if required. ☐

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ASSIGNMENT SHEET #1

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

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PREVENTIVE MAINTENANCE
UNIT VII

ASSIGNMENT SHEET #2--COMPLETE A 50-HOUR PREVENTIVE MAINTENANCE INSPECTION

NAME ______________________________ SCORE ______________

Preventive maintenance is essential for trouble-free, dependable operation. Complete the 50-hour inspection as outlined below and fill out the report sheet. Initial it, and give it to your instructor after you have completed the inspection.

(NOTE: Use with daily inspection list.)

Check (✓), Repair (R), or Adjust (A).

A. **ENGINE** (Refer to engine manufacturer's manual)

1. Check and adjust belt tension ☐
2. Tighten air cleaner connections ☐

B. **TORQUE CONVERTER AND TRANSMISSION**

1. Replace all filter elements, clean converter cooler line ☐
2. Clean breathers in solvent, and blow dry ☐

C. **DIFFERENTIALS, PLANETARY HUBS, MIDMOUNT BEARING**

1. Check front axle differential oil level ☐
2. Check front axle planetary hub oil level ☐
3. Check rear axle differential oil level ☐
4. Check rear axle planetary hub oil level ☐
5. Check midmount bearing oil level ☐

D. **FUEL SYSTEM**

1. Drain water and sediment from fuel tank ☐
2. Test operation of "quick start" unit (during cold weather) ☐

E. **ELECTRICAL SYSTEM**

1. Service batteries ☐
2. Check lights and instruments ☐

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ASSIGNMENT SHEET #2

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

Used with permission of Clark Equipment Company.

ASSIGNMENT SHEET #2

F. HYDRAULIC SYSTEM

1. Clean cylinder rods; remove nicks with fine honing stone. . . . . ☐
2. Check hydraulic system for leaks . . . . ☐
3. Clean and reinstall reservoir suction filter . . . . ☐
4. Replace reservoir return filter element . . . . ☐

G. STEERING SYSTEM

1. Clean cylinder rods with soft cloth . . . . ☐
2. Check hydraulic system for leaks . . . . ☐

H. BRAKES

1. Check brake chambers, power clusters, valves, and lines for leaks . . . . ☐
2. Check fluid level (disc brakes or air/hydraulics) . . . . ☐
3. Check hydraulic fluid level in parking brake reservoir . . . . ☐
4. Check brake air filter service indicator . . . . ☐

I. WHEELS AND RIMS

1. Tighten wheel nuts . . . . ☐
2. Inspect rims. . . . . ☐

J. LUBRICATION (Per lubrication chart)

1. Lubricate brake camshafts. . . . . ☐
2. Lubricate all 50-hour and 100-hour fittings. . . . . ☐

CHECK PERFORMED BY ____________________ DATE ____________

REMARKS ____

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ASSIGNMENT SHEET #2

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

Used with permission of Clark Equipment Company.

PREVENTIVE MAINTENANCE
UNIT VII

ASSIGNMENT SHEET #3--COMPLETE A 250-HOUR PREVENTIVE MAINTENANCE INSPECTION

NAME ____________________ SCORE ____________

Repairs are more costly and inconvenient than preventive maintenance. If you identify and correct problems early, you make your job easier and more effective. Complete the 250-hour preventive maintenance inspection outlined below and fill in the report. Initial it, and give it to your instructor after you have completed the inspection.

(NOTE: Use with daily inspection list.)

Check (✓), Repair (R), or Adjust (A).

A. **ENGINE** (Refer to engine manufacturer's manual)

1. Drain and refill crankcase . . . . ☐
2. Change lube oil filter elements . . . . ☐
3. Check engine rpm (low idle, high idle, stall) . . . . ☐
4. Adjust throttle linkage . . . . ☐
5. Drain condensation from all air tanks . . . . ☐
6. Tighten all air cleaner connections . . . . ☐
7. Check coolant level and antifreeze protection. . . . . ☐
8. Check and adjust belt tension . . . . ☐

B. **TORQUE CONVERTER AND TRANSMISSION**

1. Clean converter cooler line strainer. . . . . ☐
2. Clean breathers in solvent and blow dry . . . . ☐
3. Replace filter elements . . . . ☐

C. **BOOM AND BUCKET SYSTEM**

1. Check hydraulic system for leaks . . . . ☐
2. Check and adjust cylinder packing glands . . . . ☐
3. Adjust bucket leveler . . . . ☐
4. Adjust boom kickout . . . . ☐
5. Service return filter . . . . ☐
6. Clean suction filter . . . . ☐

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ASSIGNMENT SHEET #3

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

Used with permission of Clark Equipment Company.

ASSIGNMENT SHEET #3

D. ELECTRICAL SYSTEM

1. Check lights, instruments, and circuit breakers or fuses. ☐
2. Check specific gravity of each battery cell. ☐
3. Check condition of battery cables and terminals. ☐

E. AXLES, DIFFERENTIALS, MIDMOUNT BEARING

1. Clean midmount breather ☐
2. Check midmount oil level ☐
3. Check front and rear differential breathers ☐
4. Check front and rear differential oil levels. ☐
5. Check front axle planetary hub oil levels. ☐
6. Check rear axle planetary hub oil levels. ☐

F. AUTOMATIC CENTRAL LUBRICATION SYSTEM

1. Check grease level and refill barrel. ☐
2. Test operation of "manual" button. ☐
3. Inspect lube indicators for blockage ☐
4. Check all lube points for grease. ☐
5. Machines without automatic lubrication system: Lubricate all 50-hour fittings per lubrication chart ☐

G. FUEL SYSTEM

1. Drain fuel tank sediment and water. ☐
2. Check "quick start" cylinder; replace if necessary ☐

H. BRAKE SYSTEM

1. Check brake hydraulic accumulator precharge ☐
2. Adjust service brakes. ☐
3. Check and adjust parking brake. ☐
4. Disc brakes only:
    a. Tighten brake disc mounting bolts and bleed system; check lining wear ☐

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ASSIGNMENT SHEET #3

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

Used with permission of Clark Equipment Company.

ASSIGNMENT SHEET #3

b. Check fluid level (disc brakes or air/hydraulics) . . . . ☐

c. Check hydraulic fluid level in parking brake reservoir . . . . ☐

d. Check brake air filter service indicator . . . . ☐

I. **OPERATOR'S SEAT**--Adjust and lubricate operator's seat

J. **LOWER HINGE PIN BUSHING**--Check and adjust

K. **ACCESSORIES**--Check operation of all accessories. . . . . ☐

CHECK PERFORMED BY ______________________ DATE ____________

REMARKS ____

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ASSIGNMENT SHEET #3

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

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PREVENTIVE MAINTENANCE
UNIT VII

ASSIGNMENT SHEET #4--COMPLETE A 1000-HOUR PREVENTIVE MAINTENANCE INSPECTION

NAME ______________________________ SCORE __________

Failure to perform preventive maintenance on your equipment means not only that you lose work time and job effectiveness, but that you operate defective equipment. Complete the 1000-hour preventive maintenance inspection as outlined below and fill in the report. Initial it, and give it to your instructor after you have completed the inspection.

(NOTE: Use with daily inspection list.)

Check (✓), Repair (R), or Adjust (A).

A. GENERAL

1. Steam clean entire machine. . . . . ☐
2. Inspect main frame for cracks and damage . . . . ☐
3. Tighten mounting bolts on steering and propeller shafts. . . . . ☐

B. ENGINE (Refer to engine manufacturer's manual)

1. Clean radiator core, using compressed air, steam, or water pressure . . . . ☐
2. Drain, flush, and refill radiator to proper level; check antifreeze protection. . . . . ☐
3. Drain and refill crankcase . . . . ☐
4. Change lube oil filter elements . . . . ☐
5. Torque engine mounting bolts per chart in operator's manual . . . . ☐
6. Check engine rpm (low idle, high idle, stall) . . . . ☐
7. Adjust throttle linkage . . . . ☐
8. Drain condensation from all air tanks . . . . ☐
9. Service air cleaner body. . . . . ☐

C. TORQUE CONVERTER AND TRANSMISSION

1. Drain and refill torque converter and transmission . . . . ☐
2. Remove, clean, and reinstall transmission sump screen . . . . ☐
3. Check and adjust shift linkage. . . . . ☐

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ASSIGNMENT SHEET #4

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

Used with permission of Clark Equipment Company.

ASSIGNMENT SHEET #4

4. Check transmission de-clutch valve ☐
5. Clean converter cooler line strainer ☐
6. Clean breathers in solvent and blow dry ☐
7. Replace filter elements ☐
8. Check converter internal pressure ☐
9. Check transmission clutch, lube, and oil cooler pressure ☐
10. Tighten mounting bolts on transmission and converter ☐
11. Lubricate propeller shafts ☐

D. BOOM AND BUCKET SYSTEM

1. Check and adjust cylinder packing glands ☐
2. Check hydraulic system for leaks ☐
3. Drain, clean, and refill hydraulic system ☐
4. Check and adjust hydraulic pressure ☐
5. Adjust bucket leveler ☐
6. Adjust boom kickout ☐
7. Service reservoir return filter assemblies ☐
8. Clean reservoir suction filter assemblies ☐
9. Adjust boom and bucket control levers ☐
10. Check condition of bucket cutting edges ☐
11. Check boom-to-bucket linkage ☐
12. Check and adjust main pump bypass pressure ☐

E. ELECTRICAL SYSTEM

1. Check alternator and starting motor ☐
2. Clean and tighten electrical connections ☐
3. Check lights, instruments, and circuit breakers (or fuses) ☐
4. Check specific gravity of each battery cell ☐
5. Check condition of battery cables and terminals ☐

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ASSIGNMENT SHEET #4

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

Used with permission of Clark Equipment Company.

ASSIGNMENT SHEET #4

F. AXLES, DIFFERENTIALS, MIDMOUNT BEARING

1. Lubricate propeller shafts ☐
2. Drain and refill midmount bearing ☐
3. Clean front and rear axle breathers ☐
4. Clean front and rear differential breathers. ☐
5. Drain and refill front and rear axle differentials ☐
6. Drain and refill front axle planetary hubs ☐
7. Drain and refill rear axle planetary hubs ☐
8. Tighten front and rear axle mounting bolts. ☐
9. Clean midmount breathers ☐

G. AUTOMATIC CENTRAL LUBRICATION SYSTEM

1. Check grease level and refill barrel. ☐
2. Test operation of "manual" button. ☐
3. Inspect lube indicators for blockage ☐
4. Check all lube points for grease. ☐
5. Machines without automatic lubrication system:
   Lubricate all 50-hour and 100-hour fittings per lubrication chart ☐

H. FUEL SYSTEM

1. Drain fuel tank sediment and water. ☐
2. Check "quick start" cylinder, and replace if needed. ☐

I. BRAKE AND STEERING SYSTEMS

1. Check brake hydraulic accumulator precharge ☐
2. Clean, repack, and adjust steering gear ☐
3. Adjust steering drag link ball joints ☐
4. Check steering pressure ☐
5. Check and adjust steering pump bypass rpm ☐
6. Adjust service brakes. ☐

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ASSIGNMENT SHEET #4

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

Used with permission of Clark Equipment Company.

ASSIGNMENT SHEET #4

7. Check and adjust parking brake. . . . . ☐

8. Disc brakes only:

   a. Tighten brake disc mounting bolts and bleed system; check lining wear. . . . . ☐

   b. Replace dessicant cartridge in air dryer if required . . . . ☐

   c. Check brake air filter service indicator . . . . ☐

J. **OPERATOR'S SEAT**--Adjust and lubricate operator's seat. . . . . ☐

K. **LOWER HINGE PIN BUSHING**--Check and adjust. . . . . ☐

L. **ACCESSORIES**--Check operation of all accessories. . . . . ☐

CHECK PERFORMED BY ____________________ DATE ____________

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REMARKS ____

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ASSIGNMENT SHEET #4

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

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PREVENTIVE MAINTENANCE
UNIT VII

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1--Evaluated to the satisfaction of the instructor

Assignment Sheet #2--Evaluated to the satisfaction of the instructor

Assignment Sheet #3--Evaluated to the satisfaction of the instructor

Assignment Sheet #4--Evaluated to the satisfaction of the instructor

PREVENTIVE MAINTENANCE
UNIT VII

JOB SHEET #1--LUBRICATE A TRUCK

I. Equipment and materials

- A. Truck
- B. Manufacturer's service manual and lubrication chart
- C. Grease gun
- D. Manufacturer's recommended lubricants
- E. Engine oil, same weight as engine crankcase oil

  (NOTE: Do not mix different weights.)

- F. Solvent
- G. Stiff brush
- H. Shop rags

II. Procedure for lubricating fittings

(NOTE: See next page for typical lubrication chart [Figure 38]. The manufacturer's service manual will give exact location of all grease fittings for each piece of equipment.)

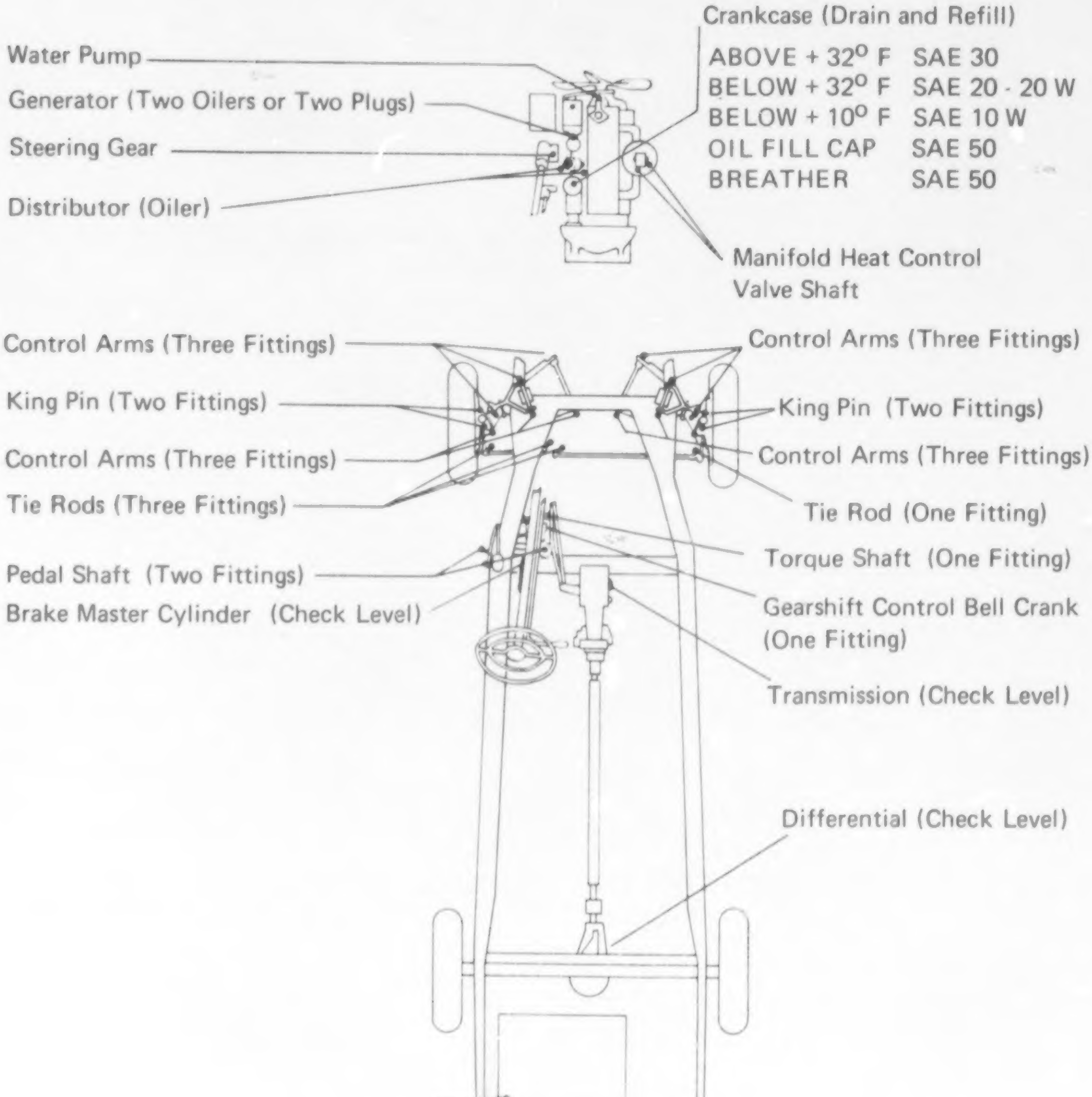
- A. Clean off grease fitting with rag and solvent
- B. Fill grease gun with proper lubricant
- C. Place gun nozzle on grease fitting; apply pressure to release grease

  (NOTE: Proper lubrication means applying the grease in correct amount. The experienced equipment operator uses neither too much nor too little lubricant.)

- D. Wipe all excess grease from fitting
- E. Repeat procedure on all grease fittings
- F. Wipe all spilled grease from floor

JOB SHEET #1

FIGURE 38


Crankcase (Drain and Refill)
ABOVE + 32° F SAE 30
BELOW + 32° F SAE 20 - 20 W
BELOW + 10° F SAE 10 W
OIL FILL CAP SAE 50
BREATHER SAE 50
Water Pump
Generator (Two Oilers or Two Plugs)
Steering Gear
Distributor (Oiler)
Manifold Heat Control Valve Shaft
Control Arms (Three Fittings)
Control Arms (Three Fittings)
King Pin (Two Fittings)
King Pin (Two Fittings)
Control Arms (Three Fittings)
Control Arms (Three Fittings)
Tie Rods (Three Fittings)
Tie Rod (One Fitting)
Torque Shaft (One Fitting)
Pedal Shaft (Two Fittings)
Brake Master Cylinder (Check Level)
Gearshift Control Bell Crank (One Fitting)
Transmission (Check Level)
Differential (Check Level)

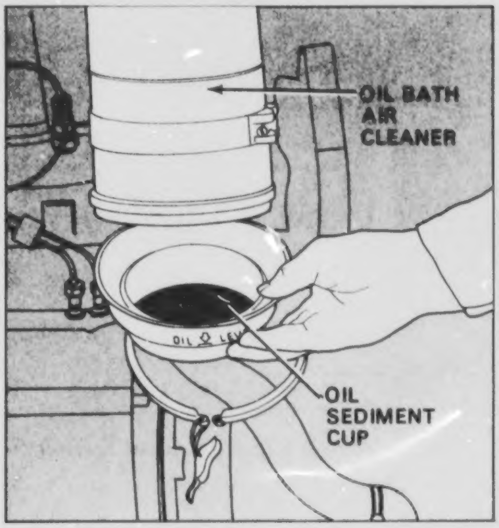
TYPICAL CHASSIS LUBRICATION CHART

JOB SHEET #1

III. Procedure for cleaning oil bath air cleaner

A. Loosen clamp and remove oil sediment cup from lower part of air cleaner (Figure 39)

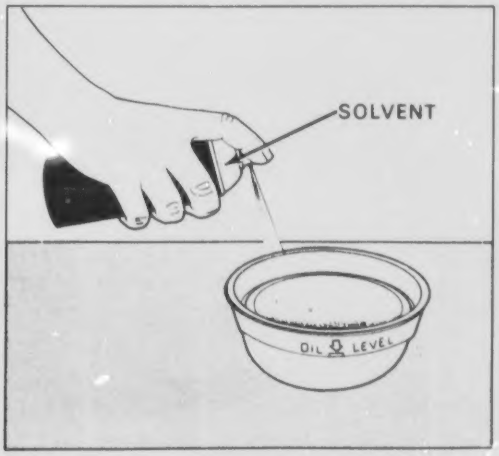
FIGURE 39


OIL BATH
AIR
CLEANER
OIL LEVEL
OIL
SEDIMENT
CUP

Used with permission of AAVIM, from *Safe Tractor Operation and Daily Care*, copyright 1981, page 27.

B. Clean cup with a solvent (Figure 40)

FIGURE 40


SOLVENT
OIL LEVEL

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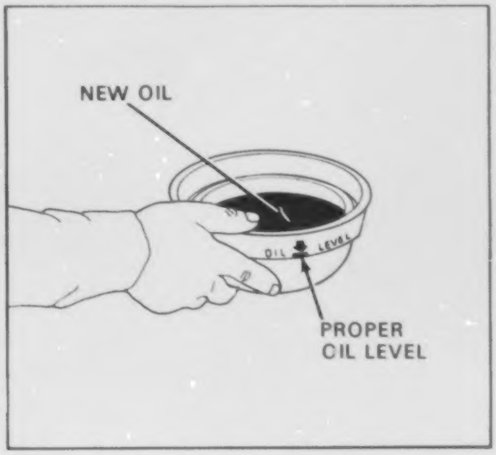
JOB SHEET #1

C. Check air-intake pipe (air stack) for dirt accumulation; clean if needed

D. Refill cup with new oil to oil level indicated on cup (Figure 41)

(NOTE: Do not overfill oil cup.)

FIGURE 41


NEW OIL
OIL LEVEL
PROPER OIL LEVEL

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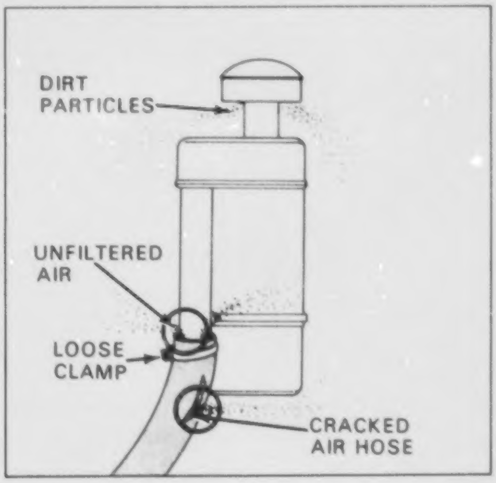
E. Replace oil cup; tighten clamp

F. Check air duct between cleaner and carburetor (or intake manifold on diesel engines) for holes for loose clamp connections (Figure 42)

FIGURE 42


DIRT PARTICLES
UNFILTERED AIR
LOOSE CLAMP
CRACKED AIR HOSE

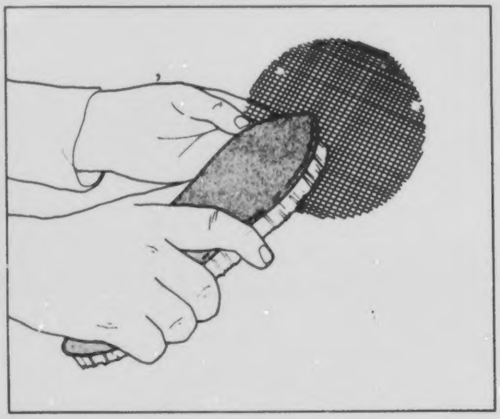
Used with permission of AAVIM, from *Safe Tractor Operation and Daily Care,* copyright 1981, page 27.

JOB SHEET #1

G. Check screened air inlet or precleaner; remove dirt with stiff brush if necessary (Figure 43)

(NOTE: Clean precleaner by removing bowl and emptying contents.)

FIGURE 43



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H. Replace screen

I. Wipe up spills

PREVENTIVE MAINTENANCE
UNIT VII

JOB SHEET #2--LUBRICATE A WHEEL LOADER

I. Tools and equipment

  A. Loader

  B. Grease gun

  C. Container of lithium-based multipurpose grease, Grade 2

  D. Shop rags

  E. Solvent

  F. Service manual and lubrication chart

  (NOTE: See next page for lubrication chart.)

II. Procedure

  A. Clean off grease fitting with solvent and rag

  B. Fill grease gun with proper lubricant

  C. Place gun nozzle on grease fitting; apply pressure to release grease

  (NOTE: The manufacturer's maintenance manual for particular piece of equipment will give locations of all grease fittings.)

  D. Wipe excess grease from fitting

  E. Proceed with steps A, B, and C until all fittings have been greased

  F. Clean all spilled grease from floor

JOB SHEET #2

LUBRICATION CHART

INTERVAL	ITEM NO.	DESCRIPTION	KEY
DAILY ⊖	1.	Boom to Upper Pivot (1 fitting each side)	LBG
	2.	Bucket Cylinder to Frame (1 fitting each side)	LBG
	3.	Boom Cylinder to Frame (2 fittings each side)	LBG
	4.	Boom Cylinder to Boom (1 fitting each side)	LBG
	5.	Bucket Cylinder to Bellcrank (1 fitting each side)	LBG
	6.	Bellcrank Pivot (1 fitting each side)	LBG
	7.	Pushrod to Bellcrank (1 fitting each side)	LBG
	10.	Front Steering Cylinder Bushings (1 fitting each side)	LBG
	11.	Steering Drag Link (2 fittings)	LBG
	13.	Lower Pivot Pin (2 fittings)	LBG
	14.	Upper Pivot Pin (1 fitting)	LBG
	18.	L.H. Rear Steering Cylinder Bushing (1 fitting)	LBG
	19.	R.H. Rear Steering Cylinder Bushing (1 fitting)	LBG
	20.	Axle Cradle Bushing (1 fitting)	LBG
	21.	Axle Cradle Bushing (1 fitting)	LBG
100 HOURS ⊟	8.	Pushrod to Bucket (1 fitting each side)	LBG
	9.	Boom to Bucket (1 fitting each side)	LBG
	12.	Propeller shaft (3 fittings)	LBG
	15.	Propeller shaft (3 fittings)	LBG
	16.	Propeller shaft (3 fittings)	LBG
	17.	Propeller shaft (3 fittings)	LBG

KEY
LBG-Lithium-based multipurpose grease
0°F and above--Grade 2
0°F and below--Grade 0

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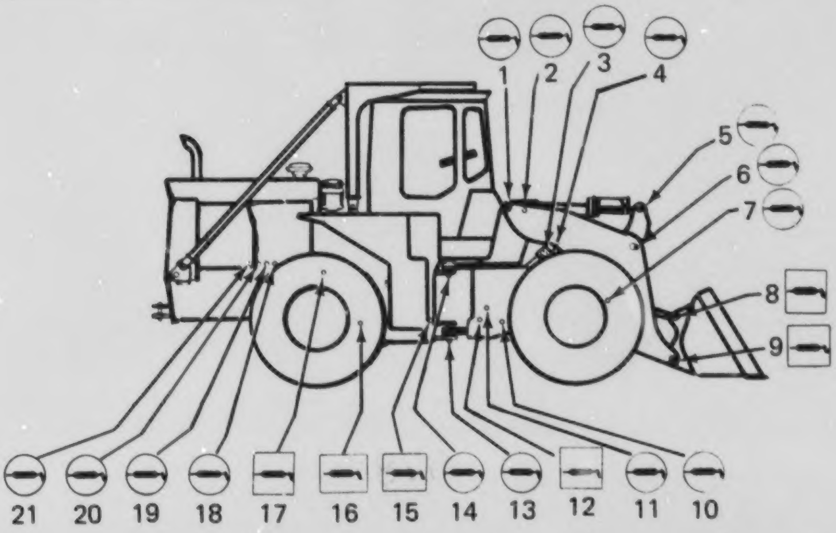


PREVENTIVE MAINTENANCE
UNIT VII

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with preventive maintenance to their correct definitions. Write the correct numbers in the blanks.

______a. Taking care of equipment systematically to reduce repairs

______b. Substance that reduces friction between surfaces

______c. Thick lubricant

______d. Type of grease

______e. Operating safety feature for gauges

______f. Device containing several oblong abrasive stones arranged in a circular pattern; used to remove small amounts of material from cylindrical surfaces

______g. Solid material that is not in solution and either is distributed through the liquid or has settled out of the liquid

______h. Device preventing leakage at a machine joint

______i. Classification of motor, transmission, and differential lubricants to indicate viscosities standardized by the Society of Automotive Engineers

______j. Metric unit of pressure similar to psi (pounds per square inch)

______k. Four-bar linkage in which both cranks traverse full circles; the fixed member must be the shortest link

1. Lubricant
2. Sender unit
3. Grease
4. Preventive maintenance (PM)
5. Alemite®
6. Packing gland
7. Kilopascal (kPa)
8. Sediment
9. Drag link
10. Honing stone
11. SAE number

2. Select from the following list factors that should be included in preventive maintenance. Write an "X" in the blank before each correct answer.

______a. Replacement of all filters

______b. Capacity of fuel tank

______c. Scheduled lubrication

TEST

______ d. Frequent cleaning of equipment

______ e. Inspections

______ f. Adjustment of all gauges

______ g. Daily inspection of lubrication system

______ h. Complete and accurate records

______ i. Prompt correction of defects

______ j. Monthly correction of all defects

______ k. Adjustments

______ l. Scheduled service

3. Select from the following list items to check in a visual inspection. Write an "X" in the blank before each correct answer.

______ a. Lights, for brightness

______ b. Switches and controls

______ c. Thermostat

______ d. Radiator

______ e. Broken master cylinder

______ f. Leaks or streaks that may indicate leaks

______ g. Dirt accumulation that could be harmful to machine

______ h. Condition of windshield

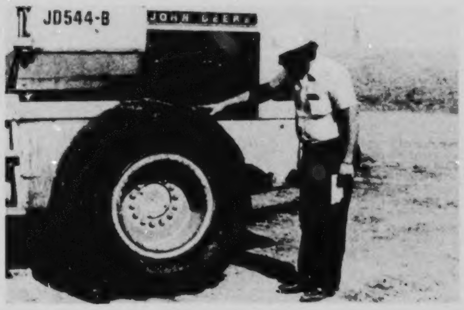
______ i. Damage and condition of tires and/or tracks and undercarriage

______ j. Condition of grease fittings

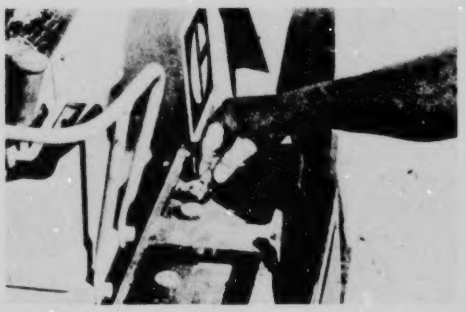
TEST

4. Identify items that should be checked on a daily (or shift) checklist. Write the correct names in the blanks.

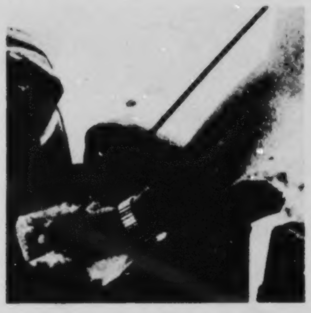
Tires and tire pressure
Visual inspection
Engine oil level
Transmission fluid level
Battery electrolyte level;
  battery connections
Hydraulic system
Brakes (testing with foot pedal)
Air cleaner indicator
Cooling system level and pressure cap
Fuel system and supply
Hydraulic fluid level on sight glass
  and/or dipstick
Insulation and connections on wires
  in electrical system



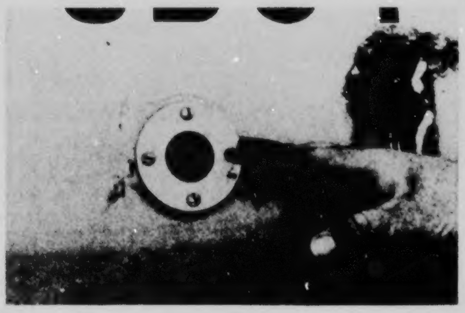
a. ______________________________



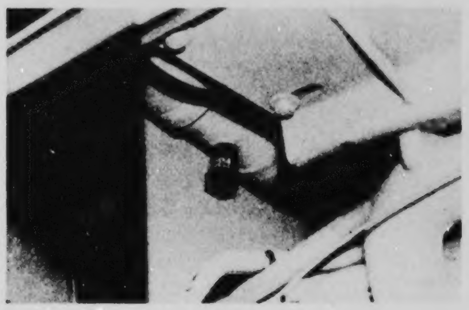
b. ______________________________



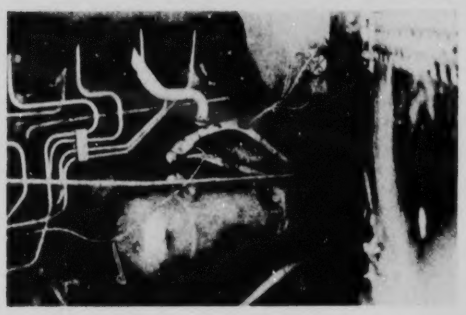
c. ______________________________



d. ______________________________

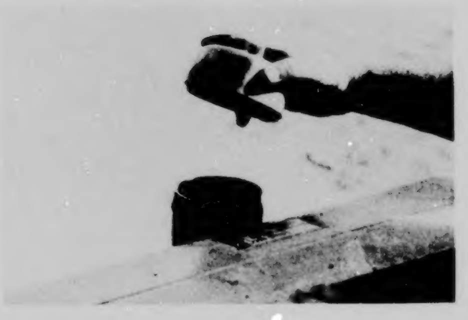


e. ______________________________

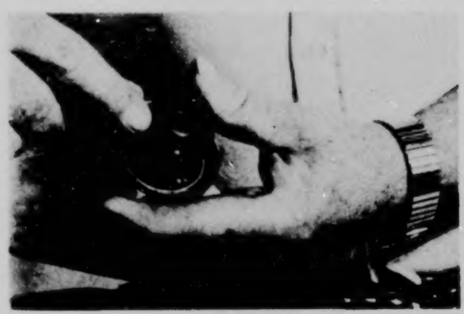


f. ______________________________

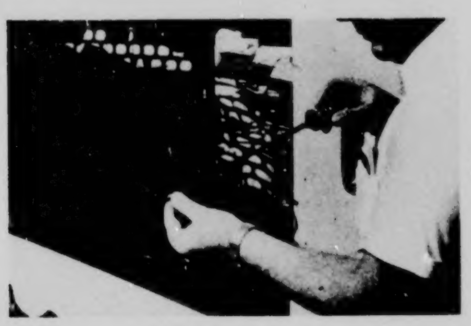
TEST



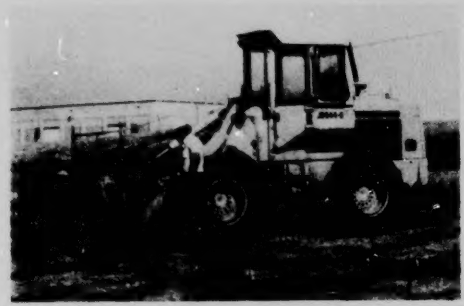
g. ____________________



h. ____________________



i. ____________________



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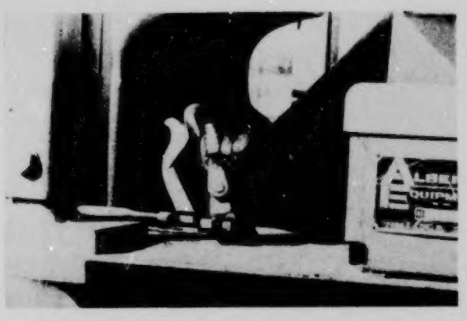
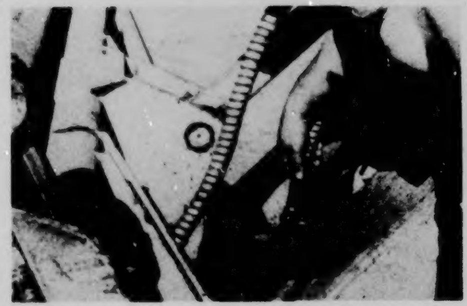


k. ____________________



l. ____________________

TEST

5. Select from the following list types of preventive maintenance inspections. Write an "X" in the blank before each correct answer.

______a. Daily

______b. Monthly

______c. 150-hour

______d. 1000-hour

______e. 300-hour

______f. 50-hour

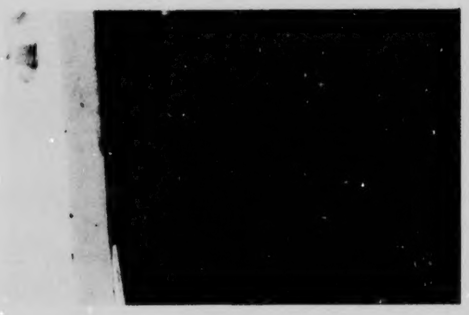
______g. Visual

______h. 1200-hour

______i. 75-hour

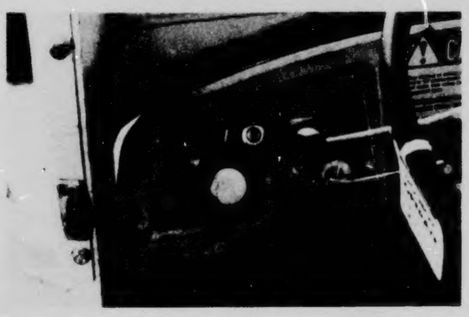
______j. 250-hour

6. Label safe service positions. Write the correct names in the blanks.



a. ________________________________

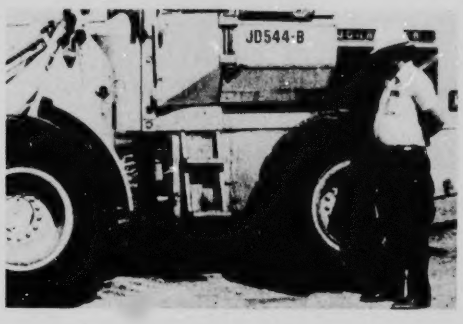
b. ________________________________



c. ________________________________

d. ________________________________

TEST



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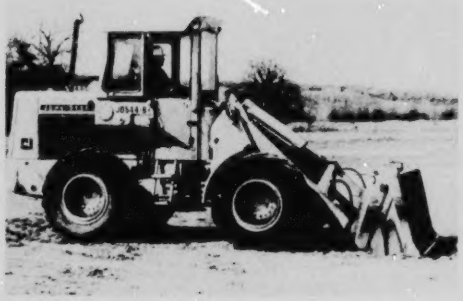

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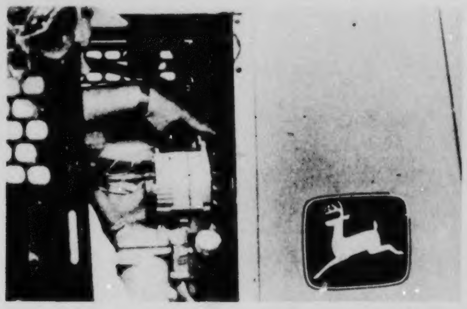
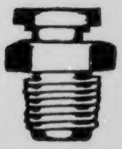


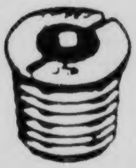
g. ______________________________

7. Identify types of grease guns and grease fittings. Write the correct names in the blanks.

- Portable air-operated pump
- Lever-type handguns
- Foot-lever bucket pump
- Grease truck
- Alemite® fitting (takes special attachment)
- Hydraulic fittings
- Handgun loader
- Pail-cover pump
- Volume-pressure bucket pump
- Flush fitting (takes special attachment)
- Push-type handgun
- Zerk fitting
- Buttonhead fitting (takes special attachment)
- Dot fitting (takes special attachment)
- Reservoir fitting

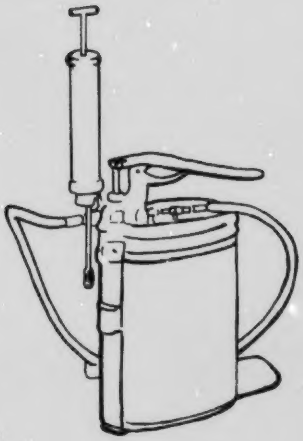


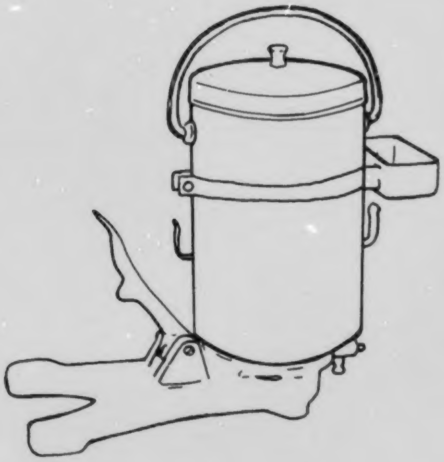
a. ______________________________



b. ______________________________

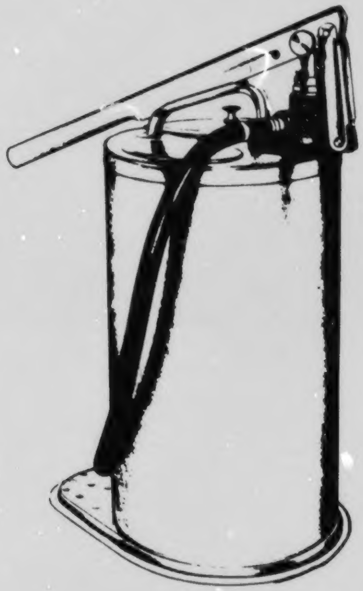
TEST

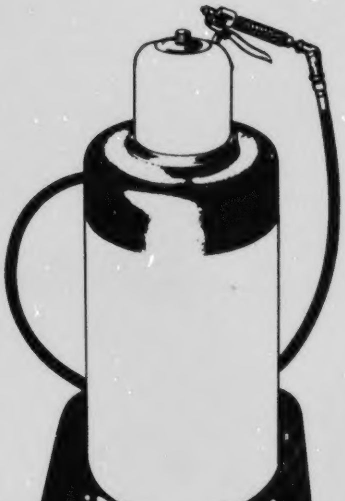




c. ______________________________

d. ______________________________

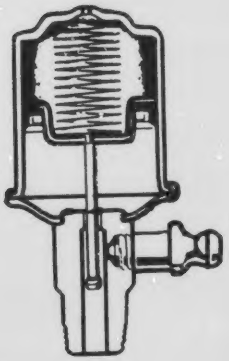


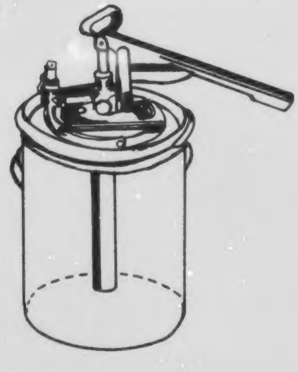


e. ______________________________

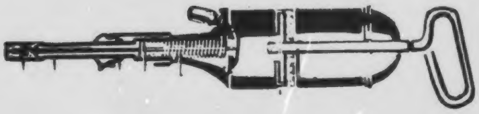
f. ______________________________

TEST

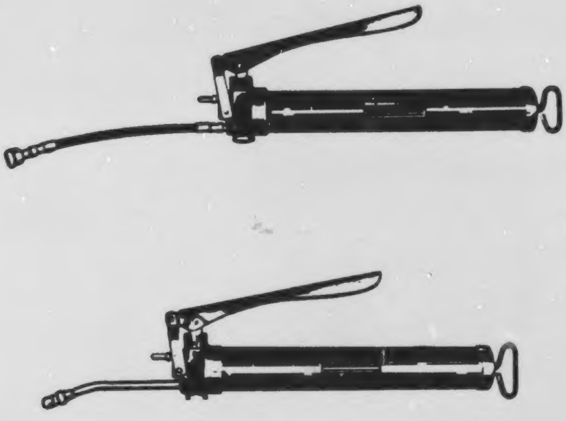


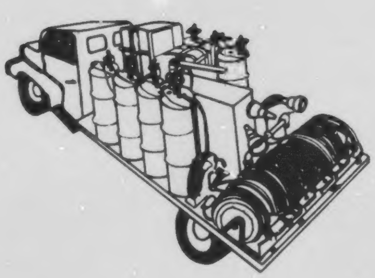


g. ______________________ h. ______________________



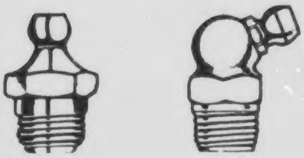
i. ______________________



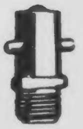


j. ______________________ k. ______________________

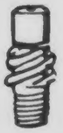
TEST



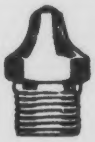
l. ______________________________



m. ______________________________

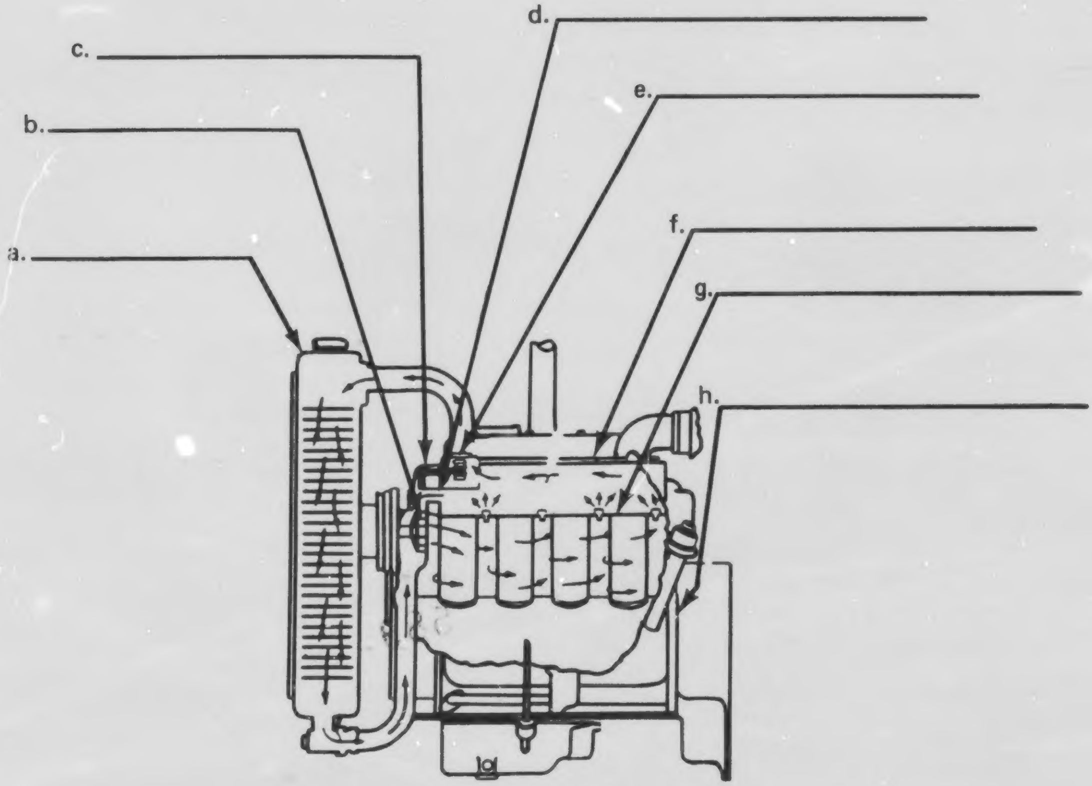


n. ______________________________



o. ______________________________

8. Label main parts of the cooling system below. Write the correct names in the blanks.



TEST

(NOTE: Test questions 9-13 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

9. Complete a daily (or shift) preventive maintenance inspection.

10. Complete a 50-hour preventive maintenance inspection.

11. Complete a 250-hour preventive maintenance inspection.

12. Complete a 1000-hour preventive maintenance inspection.

13. Demonstrate the ability to

    a. Lubricate a truck.

    b. Lubricate a wheel loader.

PREVENTIVE MAINTENANCE
UNIT VII

ANSWERS TO TEST

1. a. 4
   b. 1
   c. 3
   d. 5
   e. 2
   f. 10
   g. 8
   h. 6
   i. 11
   j. 7
   k. 9

2. c, d, e, h, i, k, l

3. b, d, f, g, i

4. a. Tires and tire pressure
   b. Battery electrolyte level; battery connections
   c. Transmission fluid level
   d. Hydraulic fluid level on sight glass and/or dipstick
   e. Air cleaner indicator
   f. Insulation and connections on wires in electrical system
   g. Fuel system and supply
   h. Cooling system level and pressure cap
   i. Engine oil level
   j. Visual inspection
   k. Brakes (testing with foot pedal)
   l. Hydraulic system

5. a, d, f, g, j

ANSWERS TO TEST

6. a. Parking brake applied
   b. Safety link connected
   c. Ignition key removed
   d. Steering wheel tagged
   e. Wheels blocked
   f. Attachment on ground
   g. Engine stopped

7. a. Buttonhead fitting
   b. Flush fitting
   c. Handgun loader
   d. Foot-lever bucket pump
   e. Volume-pressure bucket pump
   f. Portable air-operated pump
   g. Reservoir fitting
   h. Pail-cover pump
   i. Push-type handgun
   j. Lever-type handguns
   k. Grease truck
   l. Hydraulic fittings
   m. Alemite® fitting (takes special attachment)
   n. Dot fitting (takes special attachment)
   o. Zerk fitting

8. a. Radiator
   b. Water pump
   c. Water pump air vent line
   d. Bypass
   e. Thermostat (regulator)
   f. Cylinder head
   g. Cylinder liner
   h. Cylinder block

ANSWERS TO TEST

9. Evaluated to the satisfaction of the instructor
10. Evaluated to the satisfaction of the instructor
11. Evaluated to the satisfaction of the instructor
12. Evaluated to the satisfaction of the instructor
13. Performance skills evaluated to the satisfaction of the instructor

TRUCKS AND ATTACHMENTS
UNIT VIII

UNIT OBJECTIVE

After completing this unit, the student should safely be able to operate and maintain single-axle and tandem-axle trucks and their attachments: dump beds, snowplows, tailgate spreaders, and trailers. This knowledge will be shown by completing assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with trucks and attachments to their correct definitions.
2. Select from a list duties and responsibilities of the truck driver.
3. State safety rules for driving a truck.
4. Match single-axle and tandem-axle trucks and attachments to their correct uses.
5. Label parts of a dump truck.
6. Identify truck cab controls.
7. Match truck cab controls to their correct functions.
8. Select from a list guidelines for shifting gears.
9. State procedures to extend truck life.
10. Select from a list procedures to extend tire life.
11. Match components of an air brake system to their correct functions.
12. Select from a list procedures for air brake operation.
13. State safety precautions for operating the hoist.
14. State ways to detect truck defects.
15. Select from a list factors which determine dumping procedures.
16. Select from a list rules for backing a truck.
17. Select from a list procedures for batch-plant loading.
18. List causes of dump bed tip-over.
19. Select from a list procedures to prevent dump bed tip-over.

OBJECTIVE SHEET

20. State safe procedures for snow removal.
21. Select from a list hazards of snowplowing.
22. State procedures for effective snowplowing.
23. Name snowplow angles for different snow conditions.
24. Identify types of spreaders.
25. Select from a list guidelines for towing a trailer.
26. State guidelines for backing a trailer.
27. Construct a plan for a snow removal operation.
28. Analyze a snowplow route for hazards.
29. Complete an equipment inspection checklist.
30. Demonstrate the ability to

    a. Perform prestart inspection and maintenance procedures.
    b. Service a truck.
    c. Start, warm up, operate, and shut down a truck.
    d. Lubricate a hydraulic hoist.
    e. Shift a ten-speed Roadranger transmission.
    f. Engage power takeoff.
    g. Hinge a tailgate.
    h. Operate a hoist and dump bed.
    i. Prop a dump bed.
    j. Back a dump truck into a specific position.
    k. Attach a snowplow.
    l. Operate a snowplow.
    m. Attach a tailgate spreader.
    n. Operate a tailgate spreader.
    o. Operate a hopper spreader.
    p. Couple and uncouple a trailer.
    q. Back a trailer.

TRUCKS AND ATTACHMENTS
UNIT VIII

SUGGESTED ACTIVITIES

I. Suggested activities

- A. Order materials to supplement unit--Films.
    1. *Operating Tips: Trucks.* Color, 18 minutes, Caterpillar. Available from Caterpillar Film Library, Modern Talking Picture Service, Inc., 1687 Elmhurst Road, Elk Grove Village, Illinois 60007. Phone (312) 593-3250. Request #30815 Operating Tips: Trucks.

       (NOTE: An experienced operator-demonstrator explains the basic responsibilities that go with operating a truck.)

    2. *Spot the Driving Errors.* Color, 10 minutes, National Safety Council. Available from National Safety Council, 444 N. Michigan Avenue, Chicago, Illinios 60611. Phone (800) 621-8051. Request #278.07-9.

       (NOTE: This film challenges your audience of professional drivers to spot the driving errors committed in the plot action.)

    3. *Winter Driving.* Color, 10 minutes, National Safety Council. Available from National Safety Council, 444 N. Michigan Avenue, Chicago, Illinois 60611. Phone (800) 621-8051. Request #379.31-9.

       (NOTE: This film discusses highway dangers in winter and how to confront them. Combines real-life action and filming under test conditions.)

- B. Make transparency.
- C. Provide students with objective sheet.
- D. Provide students with information, assignment, and job sheets.
- E. Discuss unit and specific objectives.
- F. Discuss information and assignment sheets.
- G. Demonstrate and discuss procedures outlined in job sheets.
- H. Invite resource person to speak on defensive driving.
- I. Have students enroll in a defensive driving course.
- J. Invite resource person to speak on snow removal.
- K. Arrange a field trip to batch plant.

SUGGESTED ACTIVITIES

- L. Arrange a field trip to watch a dumping operation.
- M. Construct a model of ten-speed or twelve-speed transmission for students to practice shifting gears.
- N. Give test.

II. Instructional materials

- A. Objective sheet
- B. Suggested activities
- C. Information sheet
- D. Transparency master: TM #1--Typical Air Brake System
- E. Assignment sheets
  1. Assignment Sheet #1--Construct a Plan for a Snow Removal Operation
  2. Assignment Sheet #2--Analyze a Snowplow Route for Hazards
  3. Assignment Sheet #3--Distinguish Among Causes of Dump Bed Tip-Over
  4. Assignment Sheet #4--Complete an Equipment Inspection Checklist
- F. Answers to assignment sheets
- G. Job sheets
  1. Job Sheet #1--Perform Prestart Inspection and Maintenance Procedures
  2. Job Sheet #2--Service a Truck
  3. Job Sheet #3--Start, Warm up, Operate, and Shut Down a Truck
  4. Job Sheet #4--Lubricate a Hydraulic Hoist
  5. Job Sheet #5--Shift a Ten-Speed Roadranger Transmission
  6. Job Sheet #6--Engage Power Takeoff
  7. Job Sheet #7--Hinge a Tailgate
  8. Job Sheet #8--Operate a Hoist and Dump Bed
  9. Job Sheet #9--Prop a Dump Bed

SUGGESTED ACTIVITIES

10. Job Sheet #10--Back a Dump Truck into a Specific Position
11. Job Sheet #11--Attach a Snowplow
12. Job Sheet #12--Operate a Snowplow
13. Job Sheet #13--Attach a Tailgate Spreader
14. Job Sheet #14--Operate a Tailgate Spreader
15. Job Sheet #15--Operate a Hopper Spreader
16. Job Sheet #16--Couple and Uncouple a Trailer
17. Job Sheet #17--Back a Trailer

H. Test

I. Answers to test

III. Unit reference--*Truck Manual: Equipment Operator Training* M-53-31 (ME). Washington State Department of Transportation, February, 1977.

TRUCKS AND ATTACHMENTS
UNIT VIII

INFORMATION SHEET

I. Terms and definitions

A. Auger--Rotating drill with screw thread that carries material away from face of drill

EXAMPLE: Moves material from bed or hopper into spreader fans

B. Cab guard--Protects truck cab from falling rocks and load shift

C. Clutch--Controllable device which connects or disconnects two parts of the transmission which revolve in line with each other

D. Differential (third member)--Geared device which rotates two axles or shafts and allows them to turn at different speeds

E. Governor--Device for automatic control of speed, pressure, or temperature

F. Hinge--Connection which allows a swinging or pivotal motion in one plane

G. Hobble--To restrict movement of a hinge

H. Hopper--Open storage bin

I. Hydraulic--Powered or moved by liquid under pressure

J. Jack--Hydraulic or mechanical lifting device

K. Jackknife--Condition in which truck and trailer become jammed together at an acute angle

L. Lockout--Device that disconnects differential and turns both rear axles at same speed

M. Lug--Effect produced when engine is overloaded

(NOTE: Engine rotation is jerky, and engine sounds heavy and labored.)

N. psi--Pressure in pounds per square inch

O. Power takeoff (PTO)--Mechanical connection on an engine or transmission to which a cable, belt, or shaft can be connected to drive an attachment or tool

P. Pump--Device used to develop pressure in the transfer of fluids

Q. rpm--Revolutions per minute

INFORMATION SHEET

R. Reservoir--Storage tank

S. Slope--Ground that forms an incline

T. Split load--Load that results when material being dumped does not flow evenly from dump bed

(NOTE: A split load is more likely to occur with wet sand, clay, or asphaltic materials.)

U. Sprocket--Toothed gear that meshes with a drive chain

V. Tandem--Double-axle drive unit

W. Tongue--Extension from a towed vehicle which can be connected to a truck or tractor

X. Torque--Twisting or turning force exerted on a shaft

Y. Trailer--Towed vehicle which rests on its own wheels

Z. Trunnion--Pin or pivot mounted on bearings; used to rotate or tilt an object

AA. Windrow--Ridge of loose material (also called a "wrinkle")

II. Duties and responsibilities of the truck driver (Assignment Sheet #4)

A. Avoid abusing the truck in any way

B. Learn to recognize equipment defects immediately; report symptoms to the proper authority as soon as possible

C. Handle all road failures strictly according to departmental policies; report to proper authority

D. Make complete inspection of your unit before trip; do not leave until everything is in good working order

E. Perform daily or shift maintenance

F. Treat mechanics as your friends

G. Never make derogatory remarks about equipment or highway department

H. Promote good public relations

(NOTE: Remember that your actions and attitude while operating a truck make a lasting impression on the public. Let it be a good one.)

INFORMATION SHEET

III. Safety rules for driving a truck

A. Read operator's manual thoroughly--know your machine

B. Study departmental safety manual

C. Wear hard hat and fasten seat belt

D. Do not haul people in dump bed or on running board

E. Never get under the dump bed when it is raised unless it is securely blocked

(NOTE: Bed must be empty when propped.)

F. Do not ride the clutch

(NOTE: Your foot should be on the clutch only when shifting gears or stopping.)

G. Keep windshield, windows, and mirrors clean at all times

H. Grasp the door frame firmly when entering the cab

(CAUTION: Never enter the truck by grabbing the steering wheel.)

I. Exit from cab backwards, keeping a firm grip until your feet are on the ground

J. Never get under the truck unless the wheels are securely blocked

K. Clean slippery materials off your shoes

(NOTE: Clean shoes will help prevent slipping on steps, or having feet slip from the clutch and brake pedals.)

L. Keep truck clean

M. Set parking brake and block wheels when parking truck

N. Drive defensively

INFORMATION SHEET

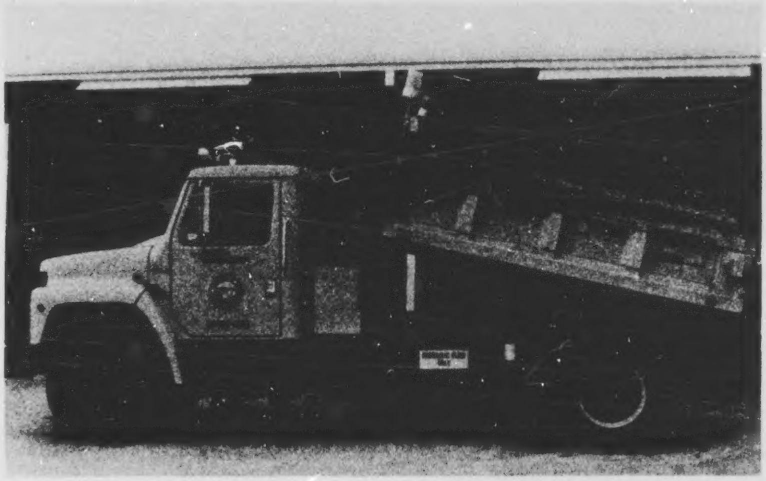
IV. Single-axle and tandem-axle trucks and attachments and their uses (Figures 1-5)

(NOTE: Trucks are used for a variety of maintenance operations. They are some of the most useful and versatile pieces of equipment the maintenance department operates.)

A. Single-axle truck--Used to haul light loads, remove snow, and pull small trailers

EXAMPLE:

FIGURE 1

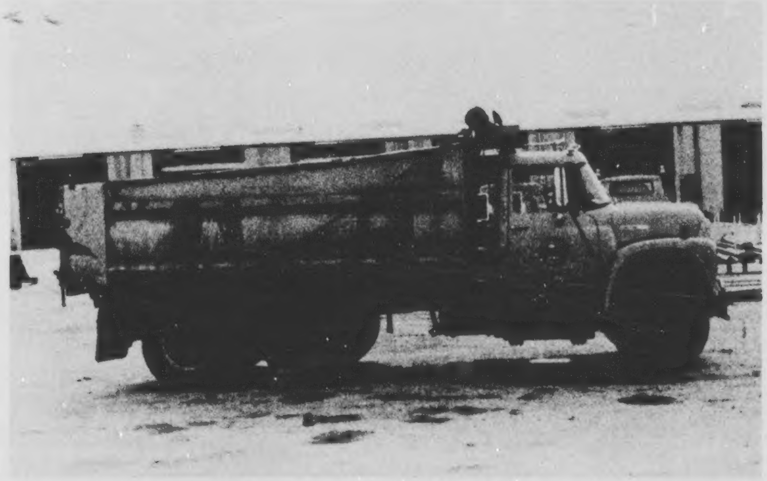


INFORMATION SHEET

B. Tandem-axle truck--Used to haul heavy loads, remove snow, and pull small trailers

EXAMPLE:

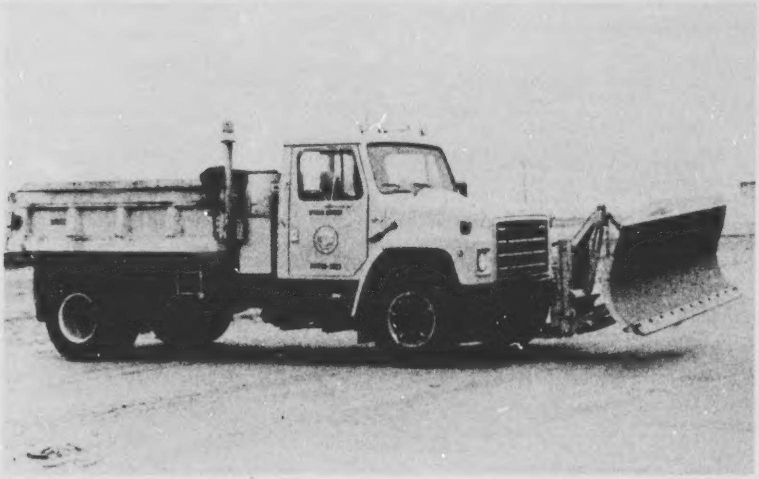
FIGURE 2



C. Snowplow--Used to remove snow from roadway

EXAMPLE:

FIGURE 3

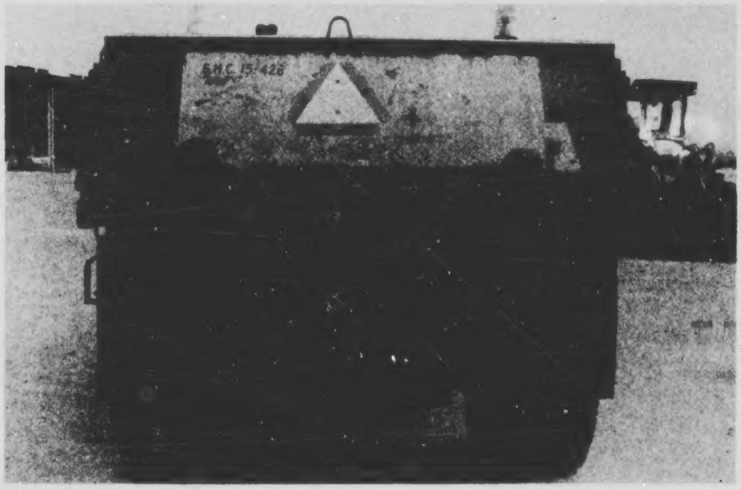


INFORMATION SHEET

D. Chip spreader--Used to spread abrasives on icy roadways (usually sand, sand and salt, chips, or cinders)

EXAMPLE:

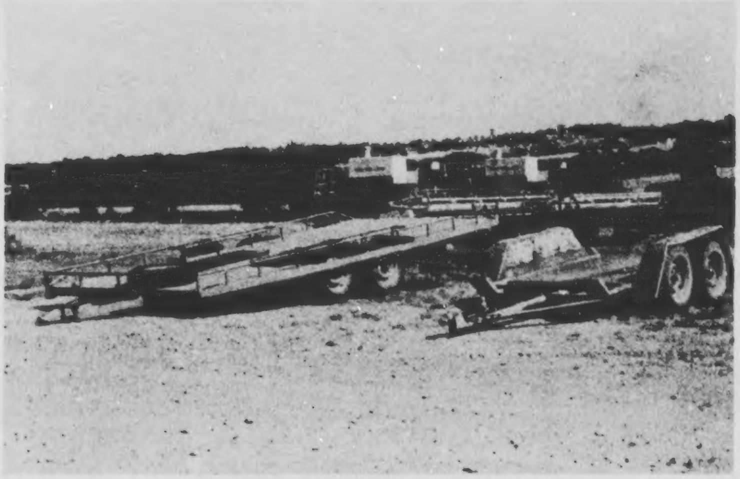
FIGURE 4



E. Tilt trailer--Used to haul equipment

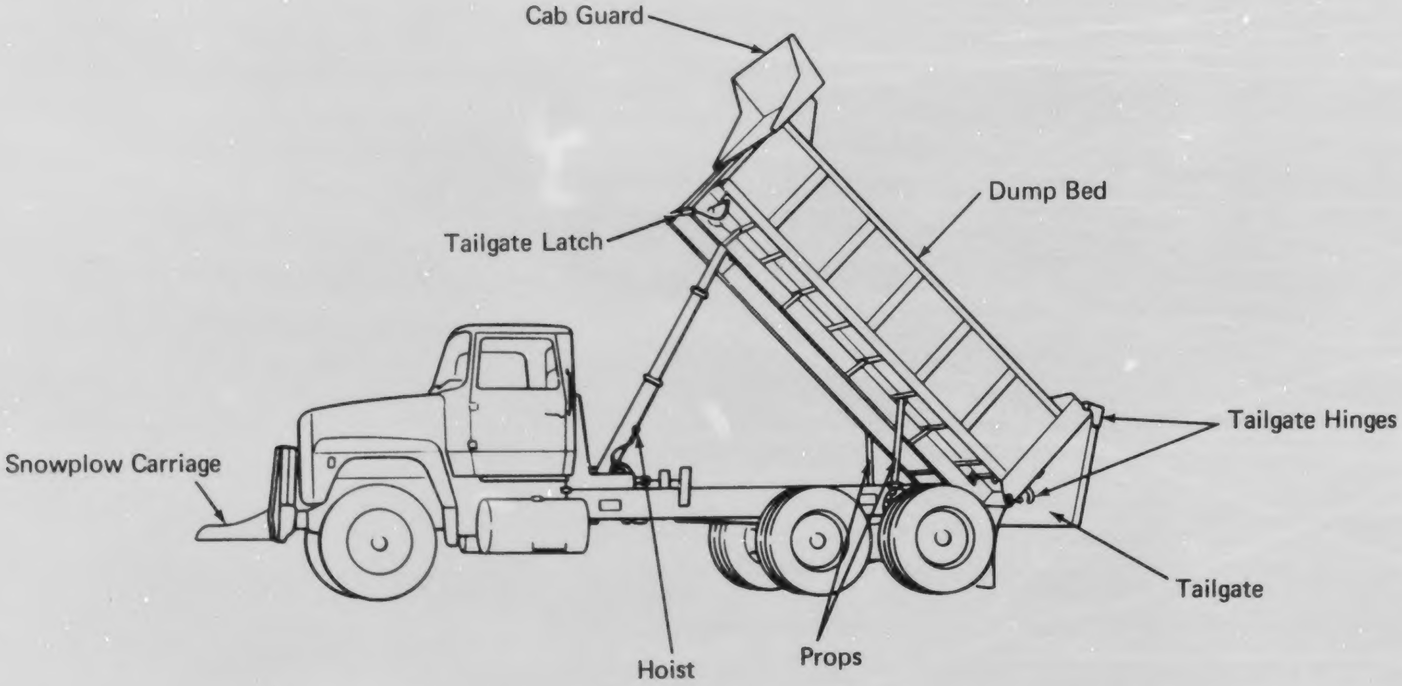
EXAMPLE:

FIGURE 5



V. Parts of a dump truck (Job Sheets #1-#2, #7-#9; Figure 6)

FIGURE 6


Cab Guard
Dump Bed
Tailgate Latch
Tailgate Hinges
Snowplow Carriage
Tailgate
Hoist
Props

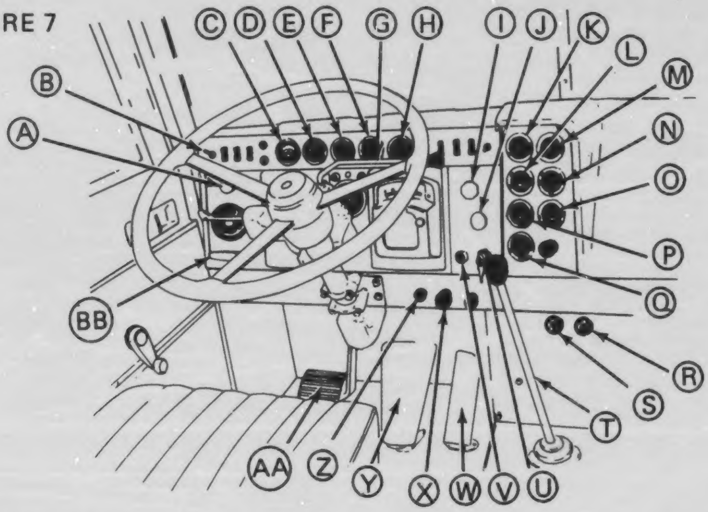
Used with permission of the Heil Company.

INFORMATION SHEET

VI. Truck cab controls (Job Sheets #3 and #5; Figure 7)

(NOTE: Location of controls will vary with manufacturer and model. This diagram is for a tandem-axle truck.)

FIGURE 7



A. Differential lockout*

B. Exhaust brake switch

C. Ammeter

D. Water temperature gauge

E. Oil pressure gauge

F. Air pressure gauge

G. Trailer brake hand control valve

H. Fuel level gauge

I. Parking brake control

J. Trailer protection valve control

K. Air pressure application gauge

L. Engine oil temperature gauge

M. Fuel pressure gauge

N. Forward rear axle oil temperature gauge*

O. Rear rear axle oil temperature gauge*

P. Transmission oil temperature gauge

Q. Auxiliary transmission oil temperature gauge*

R. Hydraulic hoist control

S. Power takeoff

T. Transmission shift control lever

U. Ignition switch

V. Starting button

W. Accelerator pedal

X. Throttle control

Y. Brake pedal

Z. Engine shutoff control

AA. Clutch pedal

BB. Emergency engine kill

*On tandem-axle trucks only

Used with permission of International Harvester.

INFORMATION SHEET

VII. Truck cab controls and their functions

A. Differential lockout--Turns both rear axles at the same speed

(NOTE: The differential lockout is engaged for hard pulls. Use caution when wheels are locked, as turning is difficult and truck is likely to skid.)

B. Exhaust brake switch--Will brake truck by slowing engine

(NOTE: Where additional braking power is needed, as in going downhill, use the exhaust brake switch rather than depleting air pressure in the brake system.)

C. Ammeter--Registers the amount of battery charge or discharge

D. Water temperature gauge--Indicates water temperature

E. Oil pressure gauge--Indicates engine oil pressure

F. Air pressure gauge--Indicates air pressure

(NOTE: Normal air pressure should be approximately 120 psi.)

G. Trailer brake hand control valve--Operates trailer brakes independently of the truck brakes

H. Fuel level gauge--Indicates amount of fuel in tank

I. Parking brake control--Used to secure truck when parked or stopped

J. Trailer protection valve control--Applies and releases parking or emergency brakes on trailer

(NOTE: This is a safety valve. If air pressure drops or trailer is disconnected, brakes will lock and stop trailer.)

K. Air pressure application gauge--Registers amount of air pressure used as brakes are applied

(NOTE: A fast, hard stop will use 120 psi, but a slow stop may require only 60-70 psi. This gauge allows the operator to apply air pressure as needed.)

L. Engine oil temperature gauge--Indicates temperature of engine oil

M. Fuel pressure gauge--Indicates fuel pressure at pump

N. Forward rear axle oil temperature gauge--Indicates oil temperature in front rear axle

INFORMATION SHEET

O. Rear rear axle oil temperature gauge--Indicates oil temperature in rear rear axle

P. Transmission oil temperature gauge--Indicates transmission oil temperature

Q. Auxiliary transmission oil temperature gauge--Indicates oil temperature in auxiliary transmission

(NOTE: Auxiliary transmission is used for hard pulling power in low gears.)

R. Hydraulic hoist control--Raises and lowers dump bed

S. Power takeoff--Operates drive train to power dump bed and attachments

T. Transmission shift control lever--Selects gears

U. Accelerator pedal--Controls engine speed

V. Starting switch--Ignition key switch

W. Starting button--Cranks engine

X. Throttle control--Controls engine speed by hand

(NOTE: This can be preset to maintain a desired rpm.)

Y. Engine shutoff control--Stops fuel to the engine

Z. Brake pedal--Stops or slows truck

AA. Clutch pedal--Engages or disengages the transmission

BB. Emergency engine kill--Stops air flow to the engine

CC. Speedometer (not pictured)--Indicates miles per hour

DD. Tachometer (not pictured)--Indicates engine rpms

INFORMATION SHEET

EE. Tailgate latch--Opens and closes tailgate (Figure 8)

FIGURE 8

OFFICIAL USE ONLY

VIII. Guidelines for shifting gears (Job Sheets #5 and #6)

(NOTE: Some tandem-axle trucks have lockout devices. Check operator's manual for proper use.)

A. Get to know your truck

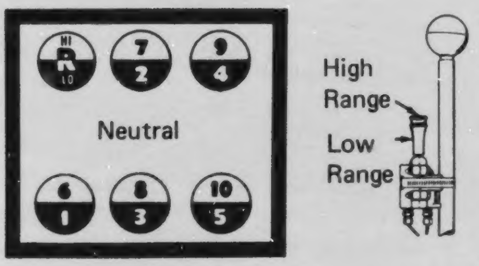
(NOTE: Listen; feel for its *usual* operating behavior.)

B. Learn the gearshift pattern for each truck (Figure 9)

(NOTE: Pattern may be mounted on dash, shift knob, or gearbox.)

EXAMPLE:

FIGURE 9


HI
R
LO
7
2
9
4
Neutral
6
1
8
3
10
5
High
Range
Low
Range

Used with permission of Washington State Department of Transportation.

INFORMATION SHEET

C. Use low range for most on-site work

D. Use high range for highway driving

E. Shift gears at proper engine rpm to avoid excessive torque action

IX. Procedures to extend truck life (Job Sheets #1-3)

(NOTE: A truck should run for 100,000 to 150,000 miles. If you abuse your equipment, you still have to drive it. Your equipment is your livelihood. Take good care of it.)

A. Keep up preventive maintenance schedule

B. Allow engine to warm up before moving truck

C. Never let engine lug

(NOTE: Keep engine operating at rpm suggested by manufacturer.)

D. Keep dump bed clean

EXAMPLES: Shovel out and rinse with water after hauling salt. Hose down with diesel fuel after hauling asphaltic material.

(CAUTION: **Be sure engine is turned off before cleaning bed with diesel fuel.**)

E. Keep moving parts properly greased

EXAMPLES: The dump bed on a truck running short hauls of 200 to 300 yards will need greasing more often than one running longer hauls; heavy dust conditions will require more frequent lubrication.

F. Distribute load properly

G. Cool off diesel engines by allowing engine to idle for a few minutes before shutdown

X. Procedures to extend tire life

A. Maintain correct air pressure to manufacturer's specifications

B. Lower speed on roads that have large, sharp-edged chuckholes

C. Do not run over curbs when turning corners or parking

D. Center vehicle in lane to avoid riding pavement edge

E. Anticipate stops in time to avoid sliding tires

INFORMATION SHEET

F. Start slowly; do not spin wheels

G. Drive at moderate speeds, particularly when heavily loaded in hot weather

H. Never run on soft or flat tires

I. Report any unusual tire wear to maintenance department

XI. Components of an air brake system (Transparency #1)

(NOTE: The air compressor furnishes air to a reservoir where it is stored for use in the brake system. The compressor operates continuously while the engine is running. A governor unloads the compressor discharge valves at 100 to 120 psi reservoir pressure. The compressor then operates without any compression until the pressure drops to between 80 and 85 psi. The safety valve, attached to the reservoir, blows off at 150 psi.)

A. Compressor--Driven by engine; furnishes compressed air to the braking system

B. Governor--Controls amount of pressure built up by compressor

C. Reservoirs--Store compressed air

D. Brake valve--Controls amount of compressed air going to and from brake chambers

E. Brake chambers--Convert compressed air into mechanical force to brake wheels; one is located at each wheel

F. Relay valve--Speeds air to brake chambers when air must travel some distance from brake valve to brake chamber

G. Quick release valve--Speeds release of air from brake chambers

XII. Procedures for air brake operation

A. Check air pressure gauge frequently

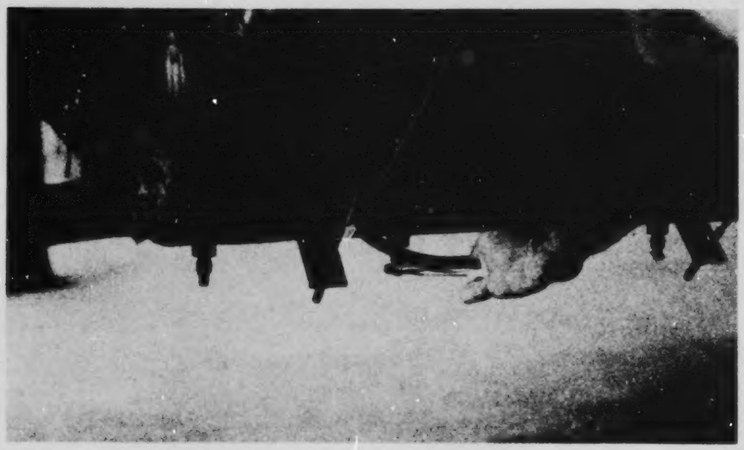
(NOTE: Sixty psi pressure is minimum. If pressure fails to build to 60 psi or exceeds manufacturer's maximum recommended psi, STOP DRIVING until fault is corrected.)

INFORMATION SHEET

B. Drain air tanks *daily* to release moisture from condensation (Figure 10)

(NOTE: If truck is equipped with automatic bleeding system, daily draining is not necessary. You must check the valve periodically to make sure it is operating properly.)

FIGURE 10



C. As you start to slow down or to stop, use as strong an application of air as conditions will permit

D. Ease air application as speed is reduced

(NOTE: By the time the truck stops, very little pressure should remain in the brake chambers.)

E. Do not pump air brakes

(NOTE: Pumping the brakes will release air pressure as you drive and leave you with no stopping power.)

F. Do not ride air brakes

G. Use gears instead of brakes as much as possible when truck is loaded

XIII. Safety precautions for operating the hoist (Job Sheets #4 and #8)

A. Use *all* safety features on truck, hoist, and bed

B. Never stand or work under a raised, *loaded* bed

C. Do not stand under a raised bed without first securely propping it

(NOTE: Bed must be empty when propped.)

INFORMATION SHEET

D. Do not leave bed raised or partly raised while vehicle is unattended unless bed is securely propped

E. When dumping, position truck on *solid, level* ground

F. Always raise and lower bed slowly

(NOTE: Rapid movement may dislodge the load and tip the truck over.)

G. Always disengage PTO when hoist is not in use

H. Report any malfunction of hoist or bed immediately

I. Stay in cab during loading and dumping operations

J. Be certain that all individuals are clear of hoist and bed before operating controls

K. Use a spotter when available

L. Be alert and watchful at all times

M. Be ready to stop operation at any time if a hazardous condition occurs

N. Look for hazards when traveling with the bed raised

EXAMPLES:
1. Overhanging wires
2. Corners of buildings
3. Overpasses
4. Tree limbs
5. Surface slopes

O. Do not ride or let any other person ride on *any* part of the vehicle other than in the cab

P. Be especially cautious when roads are icy and visibility is low

Q. Know load capacities and do not exceed them

(NOTE: Check manufacturer's specifications.)

XIV. Ways to detect truck defects

(NOTE: Any defect should be reported immediately.)

A. Feel

EXAMPLES:
1. Constant pull to right or left
2. Vibration in steering in time with wheel revolutions
3. Brakes grabbing
4. Brakes don't hold
5. Hydraulic lift moving too slowly or jerking

INFORMATION SHEET

B. Listen

EXAMPLES:
1. Metallic click in time with wheel revolutions
2. Dull thud in time with wheel revolutions
3. Clanking noise in time with wheel revolutions
4. Dull thud or loud rap in time with motor
5. Air escaping
6. Snap or click when starting from a dead stop
7. Popping in hydraulic lift
8. Other unusual noises

C. Smell

EXAMPLES:
1. Burning rubber
2. Burning oil
3. Burnt rags odor
4. Exhaust odor

D. Look

EXAMPLES:
1. Ammeter showing maximum discharge
2. Engine temperature exceeding normal reading
3. Oil pressure low
4. Water or oil line drips

XV. Factors which determine dumping procedures

(NOTE: Dumping operation should be directed by a spotter if possible. He or she will signal when to raise the bed, how fast or slow to raise the bed, when to stop raising, and when to pull forward.)

A. Type of job

EXAMPLES: Stockpiling, laying asphalt mat, spreading sand

B. Type of material

EXAMPLES: Fine sand, large rocks, hot asphaltic material

C. Condition of material

EXAMPLES: Wet, dry, cold, hot

XVI. Rules for backing a truck (Job Sheet #10)

(NOTE: Precision backing is a necessary skill. Operators must practice specific placement in order to do their jobs well.)

A. Practice backing each truck *before* loading bed

B. Use a spotter when available

INFORMATION SHEET

C. Walk around truck to make sure area is clear

D. Signal before backing

E. Use truck bed as line-of-sight guide

F. Move with extreme caution

G. Keep eyes on the mirrors at all times

H. Always proceed slowly

XVII. Procedures for batch-plant loading

(NOTE: If loading from a stockpile, back in perpendicular to stockpile so that loader or crane can load from side and you can pull straight out when loaded. Set emergency brake and stay in the truck.)

A. Adjust or hobble tailgate for dumping *before* loading

B. Secure tailgate, top and bottom hinges

C. If loading asphaltic material, hose down bed with diesel fuel or soap solution

(NOTE: Dump excess diesel fuel or soap before loading.)

D. Pull up under chute

E. Watch spotter for signals to pull forward

(NOTE: Pulling forward during loading ensures that the material is evenly distributed in the dump bed.)

F. Always stay in cab during loading

G. When loading is completed, pull well away from chute area

H. Complete necessary paperwork

XVIII. Causes of dump bed tip-over (Assignment Sheet #3)

A. Top-heavy load (Figure 11)

(NOTE: The rear portion of the load is dumped, leaving the rest of the load stuck at the front of the bed.)

1. Material stuck together
2. Material frozen in a mass
3. Material frozen to bed

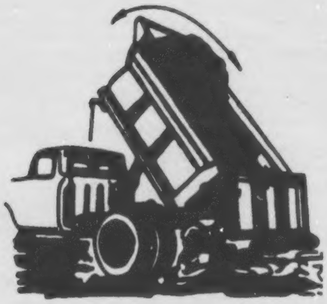
INFORMATION SHEET

4. Uneven loading

5. Uneven dumping

FIGURE 11

Top Heavy



Split Load

Used with permission of Peabody International Corporation.

B. Side load (Figure 12)

(NOTE: Material splits down the center of the bed and leaves the rest of the load completely to one side of the bed. This shifts the vertical center of gravity and can tip the unit over.)

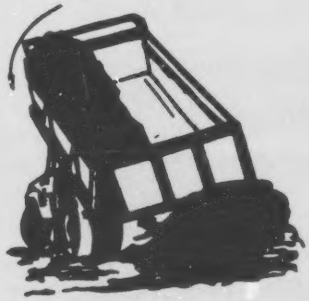
1. Uneven loading

2. Excessive rear spring deflection

3. Under-inflated tires

FIGURE 12

Side Loaded



Split Load

Used with permission of Peabody International Corporation.

INFORMATION SHEET

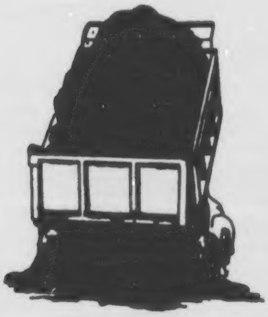
C. Excessive swaying movement in the chassis (Figure 13)

(NOTE: The following situations are encountered more frequently, so the operator should take extra care when dealing with them.)

1. Tailgating (operating with open tailgate)
2. Traveling with a raised load
3. High winds

FIGURE 13

Top Heavy



Tailgating

Used with permission of Peabody International Corporation.

XIX. Procedures to prevent dump bed tip-over

(NOTE: Proper loading technique is your best protection against tipping over.)

A. Make sure bed is empty and clean before loading

B. Load from both sides

C. Raise bed slowly

D. Keep bed washed down with diesel fuel when required

(NOTE: Any time material sticks to the dump bed, there is danger of uneven load distribution.)

EXAMPLES: When hauling asphaltic material or wet materials, when dirt or sand can freeze to the bed

E. If bed is loaded unevenly, get into the bed and even the load with a shovel

(CAUTION: Lower bed before shoveling.)

INFORMATION SHEET

XX. Safe procedures for snow removal (Assignment Sheets #1 and #2; Job Sheets #11 and #12)

A. Do not exceed appropriate speeds for equipment and conditions

B. Use all available safety warning devices

EXAMPLES: SMV signs, flashing lights, hazard lights

C. Be alert for obstructions

D. If truck skids, STEER INTO THE SKID until you regain some control, then steer back into the driving lane

E. Plow in the direction of traffic

F. Be wary of drivers coming from behind

(NOTE: Rear-end collisions are common.)

G. Wear protective clothing, especially gloves

EXAMPLES: Thermal-type woolen underwear, outer clothing which will repel wind and moisture, face helmet and head and ear coverings, two pairs of socks, warm boots, warm mittens or gloves

H. Know symptoms of cold exposure and frostbite

I. Carry container of hot liquid (not alcohol)

J. Carry emergency equipment

EXAMPLES: Flares or reflectors, first aid kit, fire extinguisher, flashlight

XXI. Hazards of snowplowing (Assignment Sheets #1 and #2; Job Sheet #12)

(NOTE: Some plows are equipped with automatic safety trips and will ride over some obstructions [See Job Sheet #12]. However, other obstructions will dislocate and/or damage the truck and plow. Always use extreme caution when plowing.)

A. Bridge expansion joints

B. Pavement expansion joints

C. Headwalls of culverts

D. Cattle guards

E. Signposts

F. Guardrails

INFORMATION SHEET

G. Hard-packed snow or ice

(NOTE: Hard-packed snow or ice can throw the truck across the roadway.)

H. Low shoulders

(NOTE: If wheel drops off, plow digs in.)

I. High shoulders

J. Raised pavement markers

EXAMPLES: Left or right turn bays, lane markers

K. Curbs

L. Islands

M. Fire hydrants

XXII. Procedures for effective snowplowing (Assignment Sheet #2; Job Sheet #12)

A. Plow from center line out to shoulders

B. "Cheat" across center line

C. Plow to low side of ramps or curves when possible

(NOTE: If plowed to the high side, the snow will melt, run across the highway, and ice over.)

D. Plow away from wind whenever possible and practical

E. Raise blade before making a turn

F. Clear snow *past* intersection before making turnaround

(NOTE: Use caution when making turnaround.)

G. Clear roadway before lifting blade; do not leave windrow of snow in traffic lane

INFORMATION SHEET

XXIII. Snowplow angles for different snow conditions (Assignment Sheet #1; Job Sheets #11 and #12)

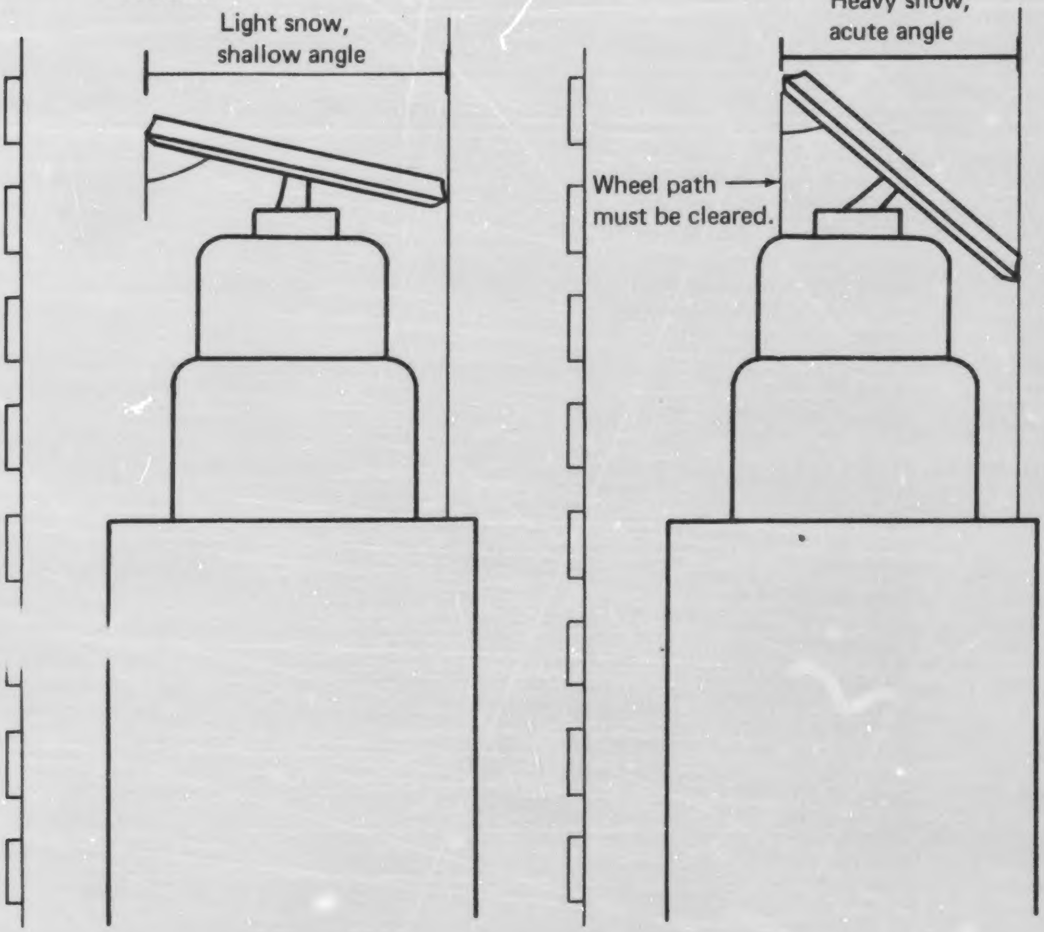
(NOTE: Angle varies with snow conditions. Check with an experienced operator until you can "sense" the proper angle. Angle should always be as shallow as conditions will allow; the greater the angle, the smaller the plow lane. Keep plow lane as wide as possible. See Figure 14.)

A. Light, dry snow--Requires shallow angle

B. Wet, heavy snow--Requires acute angle

(CAUTION: Be sure angle is not so acute that it fails to clear path for truck wheels.)

FIGURE 14


Light snow,
shallow angle
Heavy snow,
acute angle
Wheel path
must be cleared.

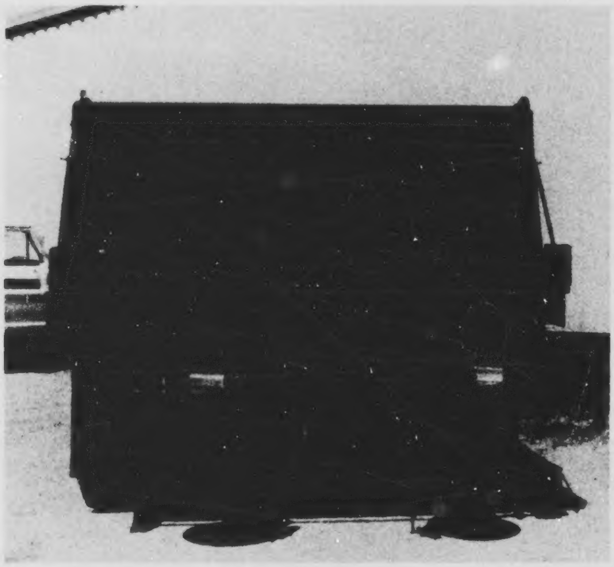
INFORMATION SHEET

XXIV. Types of spreaders (Job Sheets #13, #14, and #15; Figure 15)

A. Fan type

(NOTE: The material is slowly released into a small hopper containing an auger. On some models, fans are operated by a PTO or hydraulic motor, while others have a sprocket and chain system. The sprocket is equipped with a clutch and attaches to the right rear wheel, connecting to a clutch control in the cab. As the wheels turn, the augers revolve, feeding abrasive materials--usually sand or sand mixed with salt--into the hopper. The bed is raised a little at a time to feed the auger and hopper. If the bed is raised too high, material will overflow the hopper and must be shoveled back into the bed. The rate of distribution is set by the feed control opening and the truck speed.)

FIGURE 15



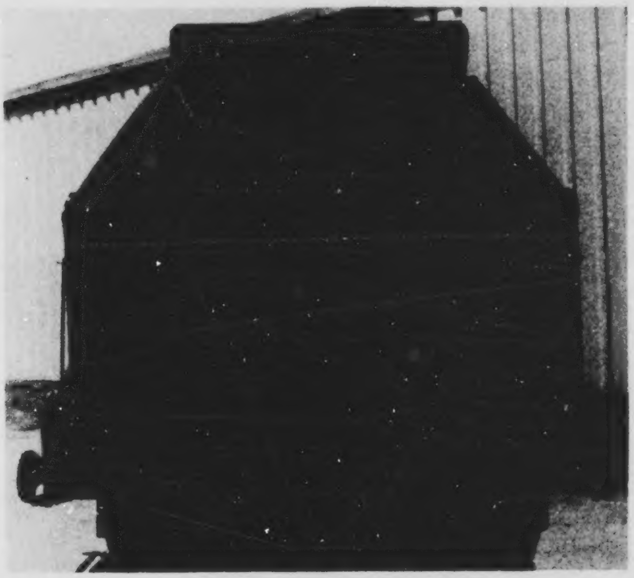
Courtesy of Swenson Spreader Company.

INFORMATION SHEET

B. Hydraulic type (Figure 16)

(NOTE: This unit attaches below the tailgate. Hydraulic controls open the attachment for the desired spread, and the tailgate is not removed. The bed is raised a little at a time to feed the spreader.)

FIGURE 16



Courtesy of Swenson Spreader Company.

INFORMATION SHEET

C. Hopper type (Figure 17)

(NOTE: The tailgate is removed; the entire spreader unit is placed in the truck bed and secured by clips, rods, and bolts. Controls are located inside the truck. A conveyor belt feeds material into a spinner fan, and the bed is not raised.)

FIGURE 17

INFORMATION SHEET

XXV. Guidelines for towing a trailer (Job Sheets #16 and #17)

A. Be sure coupling is secure

B. Allow for added length when turning, backing, and passing other vehicles

(NOTE: You will not be able to make sharp turns.)

C. Allow increased space for maneuvering truck and trailer into position

D. Signal turns well in advance of turn

E. Both trailer and truck must be equipped with the same type brakes

EXAMPLE: Air or electric brakes

F. Be especially cautious on icy roads

XXVI. Guidelines for backing a trailer (Job Sheet #17)

A. Reverse procedures used to back a straight truck

B. Use a spotter

C. Back to the LEFT whenever possible

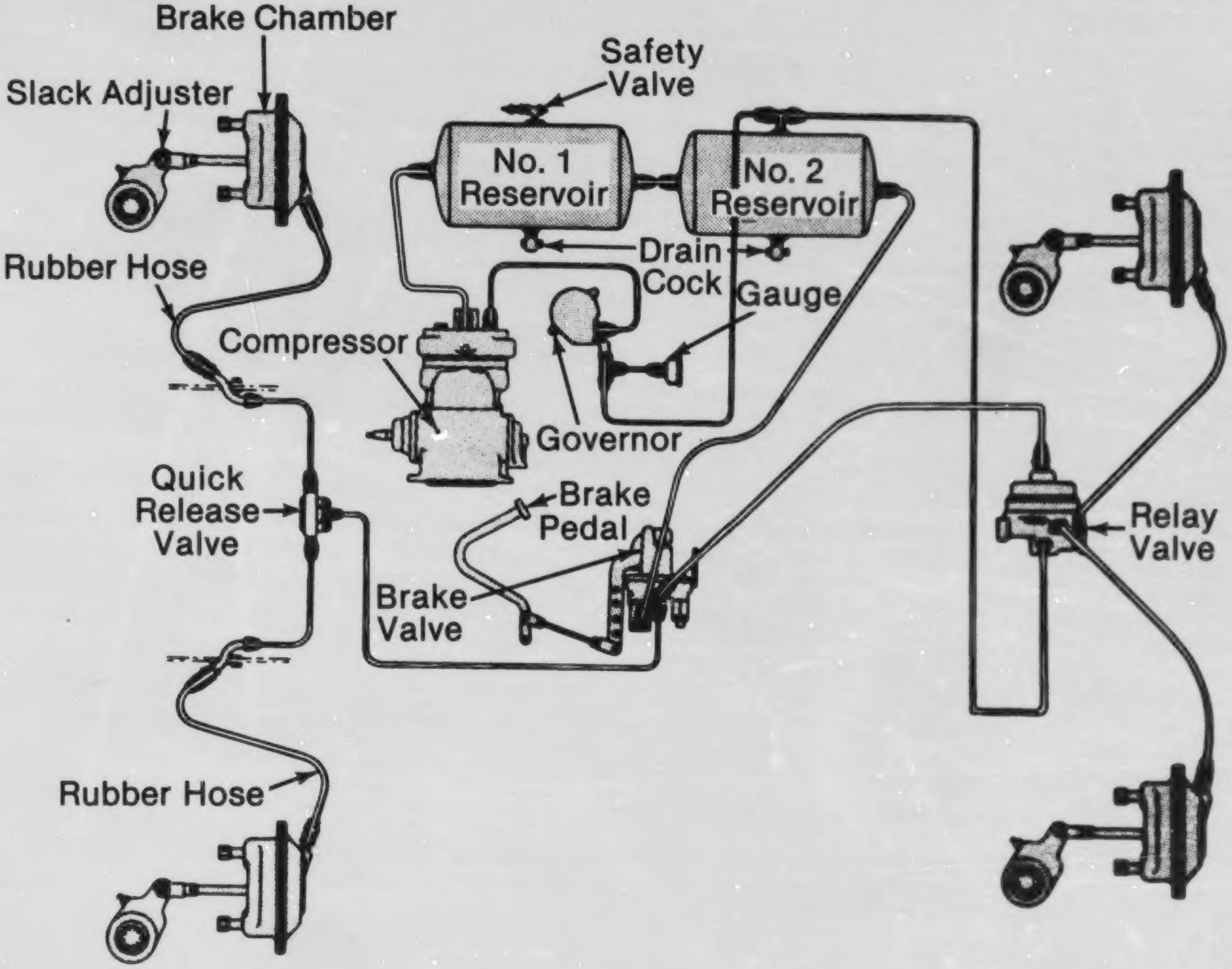
(NOTE: This is called "sight side" backing; you can see the area into which you are backing.)

D. Avoid backing to the right except when absolutely necessary

(NOTE: This is called "blind side" backing; the view is obstructed.)

(CAUTION: You must use a spotter when you are backing to the "blind side.")

Typical Air Brake System


Brake Chamber
Slack Adjuster
Safety Valve
No. 1 Reservoir
No. 2 Reservoir
Drain Cock
Gauge
Rubber Hose
Compressor
Governor
Quick Release Valve
Brake Pedal
Brake Valve
Relay Valve
Rubber Hose

TM #1

625

626

DOT I - 667

TRUCKS AND ATTACHMENTS
UNIT VIII

ASSIGNMENT SHEET #1--CONSTRUCT A PLAN FOR A SNOW REMOVAL OPERATION

NAME ______________________________ SCORE ______________

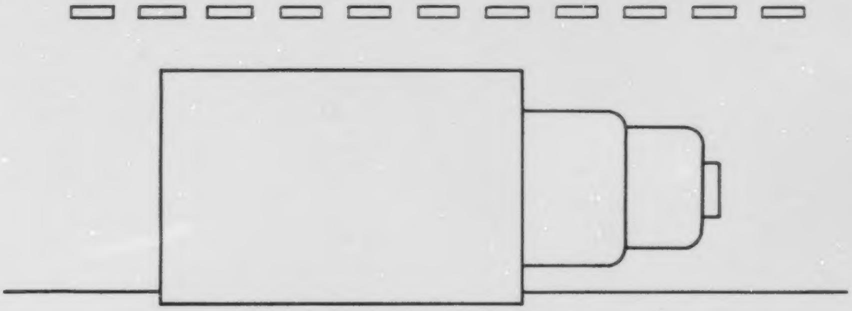
Plowing, or any snow removal operation, requires preparation and planning. For your own safety and comfort, and for the public's safety, the following factors require careful consideration.

Given the conditions below, supply the following information:

It's 3:30 P.M. in January, snowing steadily--large, light flakes, 5 to 6 inches deep. The temperature is +12°F. You are operating a tandem-axle truck with the snowplow attached. You will be plowing both sides of a two-lane highway leading from the freeway off-ramp to a suburban residential district, a distance of about 12 miles.

PART I--Plan snow removal

A. Plow angle--Show angle by drawing plow on truck



B. Clothing needed--

C. Emergency equipment needed--

ASSIGNMENT SHEET #1

D. Personal supplies-______________________________

____

____

____

____

____

PART II

A. Complete the following sentences on safety procedures for removing snow.

1. Do not exceed ______________ speeds for equipment and conditions.
2. Use all available ______________________.
3. If truck skids, steer ______________________ until you regain some control, then steer back into the driving lane.
4. Plow ______________________ of traffic.
5. Be wary of drivers coming from ______________________.
6. Be wary of ______________________ such as bridge expansion joints, pavement expansion joints, headwalls of culverts, cattle guards, signposts, guardrails, hard-packed snow or ice, low shoulders, high shoulders, raised pavement markers, curbs, islands, fire hydrants.

B. How many passes will you make? ______________________

C. What additional hazards will you have to contend with because of the time of day and the weather?

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

TRUCKS AND ATTACHMENTS
UNIT VIII

ASSIGNMENT SHEET #2--ANALYZE A SNOWPLOW ROUTE FOR HAZARDS

NAME ______________________________ SCORE ______________

In addition to the general hazards of snow removal, each operation will present its own hazards for the operator. This assignment sheet requires you to study the route map at the end of this assignment sheet and anticipate the specific hazards of this roadway.

You are to start at 5 A.M. and plow this route from the sloped off-ramp to the village city limits, a distance of 12 miles.

A. Mark the route you will plow.

1. Where will you start?______________________________
2. Where will you make the turnaround?______________________
3. Where will you end plowing?__________________________

B. Explain why you chose this route--__________________________

____

____

____

____

____

C. Circumstances which require special procedures are represented on the map by circled letters. Write the correct letter in the blank before each of the following procedures. Some answers may be used more than once.

__________ 1. Watch for raised pavement markers

__________ 2. Plow to the low side of the ramp

__________ 3. Lift plow to turn corner

__________ 4. Lift plow for turnaround

__________ 5. Pay special attention on curves

__________ 6. Clear snow past the intersection

ASSIGNMENT SHEET #2

D. Mark the map to indicate potential hazards, using the numbering code below. There is added danger because you are plowing in the dark.

1--Guardrails

2--Signposts

3--Bridge expansion joints

4--Change in speed zones

5--Increased traffic flow

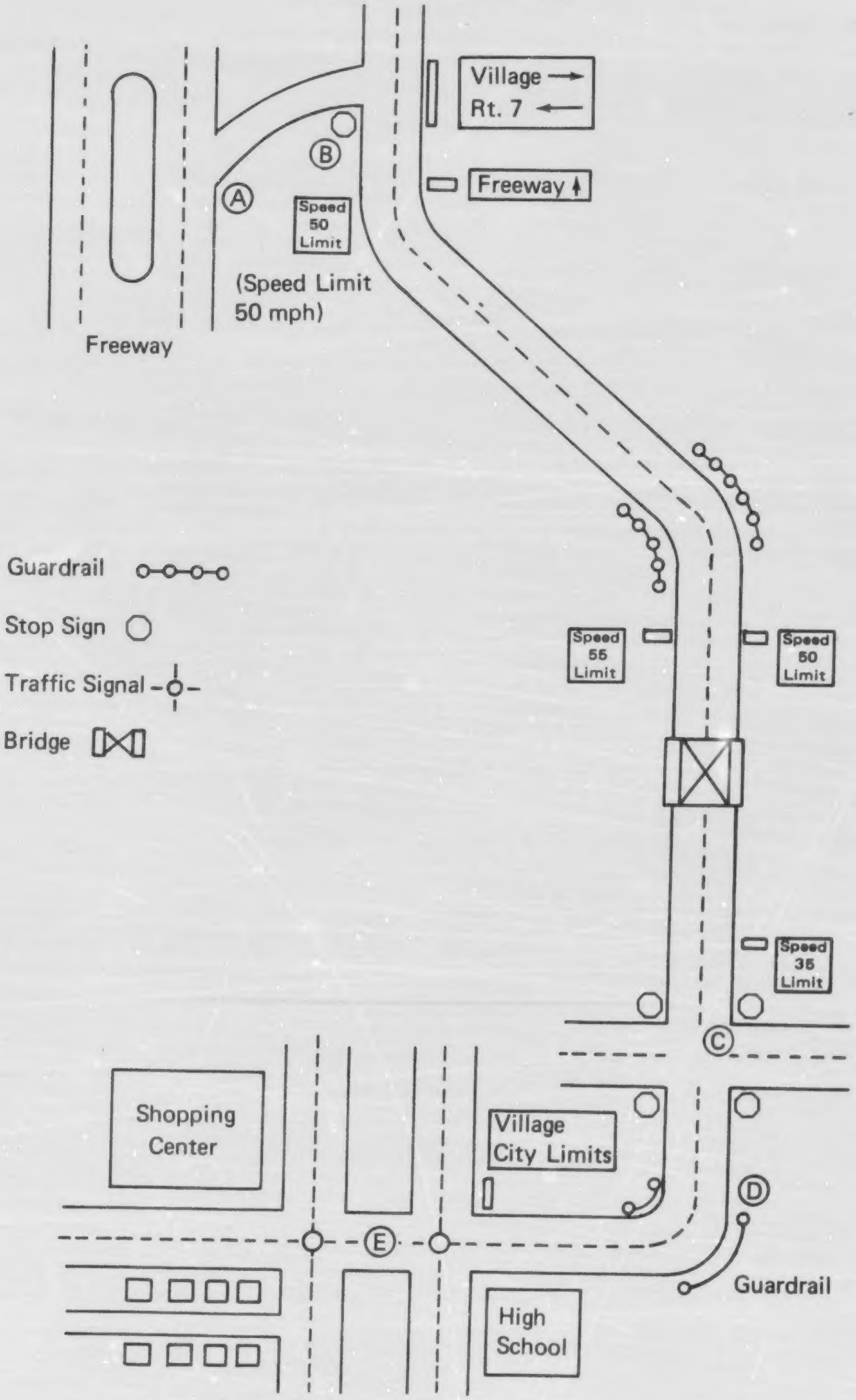
E. What safety warning devices will you use?

1. ______________________________

2. ______________________________

3. ______________________________

ASSIGNMENT SHEET #2


Village →
Rt. 7 ←
Freeway ↑
B
A
Speed 50 Limit
(Speed Limit 50 mph)
Freeway
Guardrail
Stop Sign
Traffic Signal
Bridge
Speed 55 Limit
Speed 50 Limit
Speed 35 Limit
C
Shopping Center
Village City Limits
D
E
Guardrail
High School

TRUCKS AND ATTACHMENTS
UNIT VIII

ASSIGNMENT SHEET #3--DISTINGUISH AMONG CAUSES OF DUMP BED TIP-OVER

NAME ______________________________ SCORE ______________

Dump bed tip-over is a serious hazard for the operator. It is essential that you know the causes and be alert to a potential tip-over situation.

A. In the left-hand column below are factors that can lead to the tip-over conditions listed in the right-hand columns. Write an "X" in the blank(s) under the conditions produced by the factors listed in the left-hand column. A factor may produce more than one condition.

FACTORS	CONDITIONS		
	Top-heavy load	Side load	Excessive swaying movement in chassis
1. Under-inflated tires	______	______	______
2. Material stuck together	______	______	______
3. Excessive rear spring deflection	______	______	______
4. High winds	______	______	______
5. Material frozen to bed	______	______	______
6. Uneven loading	______	______	______
7. Traveling with raised load	______	______	______
8. Uneven dumping	______	______	______
9. Tailgating (operating with open tailgate)	______	______	______
10. Material frozen in a mass	______	______	______

ASSIGNMENT SHEET #3

B. Talk to an operator about any experiences with truck tip-over. Write down the cause, the weather conditions, the kind of material being hauled, and any other important factors.

1. ____________________

2. How could that accident have been prevented? ____________________

TRUCKS AND ATTACHMENTS
UNIT VIII

ASSIGNMENT SHEET #4--COMPLETE AN EQUIPMENT INSPECTION CHECKLIST

NAME ______________________________________ SCORE ________________

(NOTE: Complete this assignment sheet only after you have enough experience starting and operating a truck to know what you are doing and what you are looking for.)

Daily equipment inspection is the key to good preventive maintenance. The inspection is your first responsibility for operating your equipment. Familiarize yourself with inspection procedures and keep accurate records.

Follow the order of inspection on the following equipment checklist. Some of the items are visual only, and some require that you start the engine and inspect the item under operating conditions. When you have completed the inspection, sign the form and turn it in for your instructor's signature.

DOT I - 679

ASSIGNMENT SHEET #4

White - Maintenance
Pink - District
Yellow - Area
Blue - Vehicle

EQUIPMENT INSPECTION CHECKLIST

District ____________
Area ____________
Inspection No. ________

DOT No. ____________ Make ______________ Type ______________ Date ____________

INSTRUCTIONS

Use left hand column to insure all applicable items are checked, ✓ or marked not applicable NA .
Use right hand blocks ONLY to note items that need attention. ☒

CAB INTERIOR

1. ___ Brakes (foot) ☐
2. ___ Clutch ☐
3. ___ Brake (emergency) ☐
4. ___ Glass (incl. window channels) ☐
5. ___ Mirrors ☐
6. ___ Seats (condition & seat belts) ☐
7. ___ Heater & Defroster (motor & controls) ☐
8. ___ Windshield Wipers & Washer ☐
9. ___ Starter ☐
10. ___ Generator or Alternator ☐
11. ___ Horn ☐
12. ___ Backup Warning Device ☐
13. ___ Air Conditioning ☐
14. ___ First Aid Kit ☐
15. ___ Fire Extinguisher ☐
16. ___ Reflectors or Fuses ☐
17. ___ Accident Instructions ☐

ENGINE COMPARTMENT

18. ___ Crankcase (oil level & leaks) ☐
19. ___ Radiator (cap, level, leaks) ☐
20. ___ Air Cleaner (incl. condition indicator) ☐
21. ___ Power Steering (level & leaks) ☐
22. ___ Brakes (travel, level & leaks) ☐
23. ___ Transmission (auto. fluid level) ☐
24. ___ Battery (level, bracket, terminals) ☐
25. ___ Belts (condition & tension) ☐
26. ___ Air Compressor & System ☐
27. ___ Engine (oil consumption & cleanliness) ☐
28. ___ Hood Latches & Hinges ☐

UNDER CHASSIS

29. ___ Transmission (filters, level & leaks) ☐
30. ___ Differential (level & leaks) ☐
31. ___ U-joints & Drive Shaft ☐
32. ___ Hydraulic System (level & leaks) ☐
33. ___ Suspension (wheels, shocks & springs) ☐
34. ___ Exhaust System (leaks & manifold heat valve) ☐
35. ___ Hanging Wires or Hoses ☐
36. ___ Tandem Case, all Gear Cases ☐

WALK AROUND

37. ___ Lights (incl. trailer connection) ☐
38. ___ Tires (wear & inflation) ☐
39. ___ General Condition of Body ☐
40. ___ Cleanliness ☐
41. ___ License Tag ☐

RUN CHECK (if possible)

42. ___ Engine (oil pressure & temp.) ☐
43. ___ Engine Governor ☐
44. ___ Steering ☐
45. ___ Clutch ☐
46. ___ Transmission ☐
47. ___ Brakes ☐
48. ___ Panel Instruments ☐
49. ___ Hydraulic Equipment ☐
50. ___ Control Levers & Cables ☐
51. ___ Auxiliary Equipment ☐
52. ___ Unusual Noises ☐

Operator's Remarks & Signature ____

____

____

____

☐ Needs immediate attention - Safety Hazard

☐ Needs attention. (Check only if blocks are checked above.)

Signed ______________________
Supervisor

TRUCKS AND ATTACHMENTS
UNIT VIII

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

PART I

A. Shallow angle

B. Answer should include the following

   1. Water-resistant outerwear
   2. Thermal underwear
   3. Warm gloves
   4. Hat
   5. Face covering (scarf or muffler)
   6. Two pairs of socks
   7. Waterproof boots

C. 1. Flares or reflectors
   2. First aid kit
   3. Fire extinguisher
   4. Flashlight

D. Container of hot liquid (answer also may include food, extra socks, sunglasses)

PART II

A. 1. Appropriate
   2. Safety warning devices
   3. Into the skid
   4. In the direction
   5. Behind
   6. Hazards

B. Three

ANSWERS TO ASSIGNMENT SHEETS

C. 1. Low visibility

2. Will be plowing after dark

3. Will be plowing in rush-hour traffic

4. Cold exposure and frostbite

Assignment Sheet #2

A. 1. At freeway off-ramp (first pass should "cheat" over center line)

2. *Past* intersection at city limits (should clear intersection before the turnaround)

3. Past intersection at city limits

B. Most efficient route, clears heavy traffic area before rush hour

C. 1. C

2. A

3. B

4. E

5. D

6. E

D. Evaluated to the satisfaction of the instructor

E. Answer may include any three of the following

1. SMV sign

2. Flashing lights

3. Hazard lights

4. Headlights

Assignment Sheet #3

A. 1. Side load

2. Top-heavy load

3. Side load

ANSWERS TO ASSIGNMENT SHEETS

4. Excessive swaying movement in the chassis

5. Top-heavy load

6. Top-heavy load, side load

7. Excessive swaying movement in the chassis

8. Top-heavy load

9. Excessive swaying movement in the chassis

10. Top-heavy load

B. Evaluated to the satisfaction of the instructor

(NOTE: You may want students to share their interviews with the class.)

Assignment Sheet #4--Evaluated to the satisfaction of the instructor

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #1--PERFORM PRESTART INSPECTION AND MAINTENANCE PROCEDURES

I. Equipment and materials

- A. Single-axle or tandem-axle truck
- B. Operator's manual
- C. Engine oil
- D. Engine coolant
- E. Hydraulic fluid
- F. Fuel
- G. Lubricants
- H. Grease gun
- I. Rags

II. Procedure

(NOTE: Deficiencies should be corrected immediately or reported to the proper authority. Do not operate defective equipment.)

- A. Make a walk-around visual inspection for broken, worn, or missing parts, and leaks
- B. Check engine oil level; add or change oil if needed
- C. Check engine coolant level; add coolant if needed
- D. Check hydraulic reservoir level; add fluid if needed
- E. Check fuel level; fill tank if needed
- F. Check battery connections for tightness and corrosion
- G. Check battery electrolyte level; add water if needed
- H. Check air cleaner; remove and clean filter if needed
- I. Check brakes and make sure air tanks have been drained
- J. Check condition of tires

JOB SHEET #1

K. Clean all grease fittings and lubricate according to operator's manual

L. Check hydraulic system for leaking lines and connections, bent or kinked lines, lines rubbing against other parts

M. Check drive belts for tightness

N. Check electrical wire connections and insulation

O. Clean windshield and mirrors; adjust mirrors

P. Check gauges

Q. Check foot pedals for proper functioning

R. Check levers and controls for proper functioning

S. Remove trash

T. Check lights

U. Check safety devices

V. Check two-way radio

W. Check dump bed; clean if needed

X. Check hoist for proper functioning

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #2--SERVICE A TRUCK

I. Equipment and materials

   A. Single-axle or tandem-axle truck

   B. Operator's manual

   C. Tool kit

   D. Air supply

   E. Grease gun

   F. Lubricants

   G. Cleaning solvents

   H. Rags

   I. Water

   J. Engine coolant

   K. Engine oil

   L. Hydraulic fluid

   M. Transmission fluid

   N. Brake fluid

   O. Tire pressure gauge

   P. Fuel

II. Procedure

(NOTE: Follow departmental preventive maintenance program when servicing equipment. Refer to operator's manual for lubrication chart and for servicing specific components and attachments.)

   A. Visually inspect for broken, worn, or missing parts; look for leaks

   (NOTE: Major repairs and replacements should be reported to the proper authority and completed by a trained mechanic.)

   B. Check engine oil level, filter, lines and hoses; add engine oil if needed

JOB SHEET #2

C. Check engine coolant level, radiator cap, hose, and radiator; add coolant if needed

(CAUTION: Do not remove radiator cap unless engine is cool; then, open cap slowly to release pressure.)

D. Clean air filter; replace if needed

E. Check fuel level, fuel filters, and sediment bowl (where applicable); fill fuel tank

F. Check battery electrolyte level, battery cables, and connectors; add water or electrolyte if needed

(NOTE: Keep sparks and fire away from battery.)

G. Check exhaust system for loose connections and holes

H. Check hydraulic fluid level, filters, hose, lines, and fittings; and look for leaks; add fluid if needed

I. Check transmission fluid level; add fluid if needed

J. Check transmission pressure line filter and breather

K. Check brake adjustment and condition; adjust as needed

L. Check air brake system for leaks

M. Check clutch adjustment; adjust if necessary

N. Check drive belts for tension and wear; adjust or replace if needed

O. Check wiring, insulation, and connections

P. Clean and lubricate grease fittings according to operator's manual

Q. Check tire pressure, inflate to recommended pressure if low

R. Check condition of tires

S. Check all safety devices; repair if necessary

T. Check major components and/or accessories

1. Dump bed
2. Hoist
3. Attachments, if any

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #3--START, WARM UP, OPERATE, AND SHUT DOWN A TRUCK

I. Equipment and materials

  A. Single-axle or tandem-axle truck

  B. Operator's manual

II. Procedure

  A. Read operator's manual thoroughly

  B. Perform prestart inspection and maintenance

  C. Mount truck properly

  (NOTE: Do not grab steering wheel when climbing into truck.)

  D. Take position in driver's seat and fasten seat belt; make sure emergency brake is on

  E. Learn gear positions

  (NOTE: Positions may be mounted on dash, shift knob, or gear box.)

  F. Check axle control knob to be sure that it is in correct position

  (NOTE: Check operator's manual.)

  G. Depress clutch

  (NOTE: Automatic transmissions do not have a clutch. Push the pedal *all the way* down to the floorboard; when releasing it, release it all the way.)

  (CAUTION: Never drive with foot on clutch pedal. Avoid unnecessary and excessive slipping of the clutch. Do not engage clutch suddenly.)

  H. Place gearshift in neutral

  I. Turn key to start engine

  J. Let engine run for five minutes; listen for defects

  (NOTE: In cold weather, follow operator's manual for cold weather starting procedures.)

  K. Check gauges and make sure air system has reached normal line pressure

  L. Depress clutch

  M. Shift to appropriate gear

  (NOTE: Check operator's manual.)

JOB SHEET #3

N. Check for clearance in all directions

O. Release emergency brake

P. Depress accelerator

Q. Release clutch

R. Drive truck slowly

(NOTE: Stay in low gear range if truck is equipped with two-speed transmission.)

S. Practice turning and stopping until clutch action is smooth

T. Stop truck

U. Place gearshift in neutral position

V. Set emergency brake

W. Turn key to OFF position

(NOTE: If truck has diesel engine, run at idle for two to three minutes before shutting engine down. This permits engine to cool and allows for gradual and uniform cooling of engine parts.)

X. Dismount truck properly

Y. Make walk-around inspection and note leaks, broken or missing parts; report any deficiencies to the proper authority

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #4--LUBRICATE A HYDRAULIC HOIST

I. Equipment and materials

A. Hydraulic hoist

B. Grease gun

C. Container of grease recommended by chassis manufacturer

D. Rags

E. Service manual and lubrication chart (Figure 18)

(NOTE: See next page for typical lubrication chart.)

II. Procedure

A. Fill grease gun with proper lubricant

B. Clean off grease fitting with rag

C. Place gun nozzle on grease fitting and apply pressure to release grease

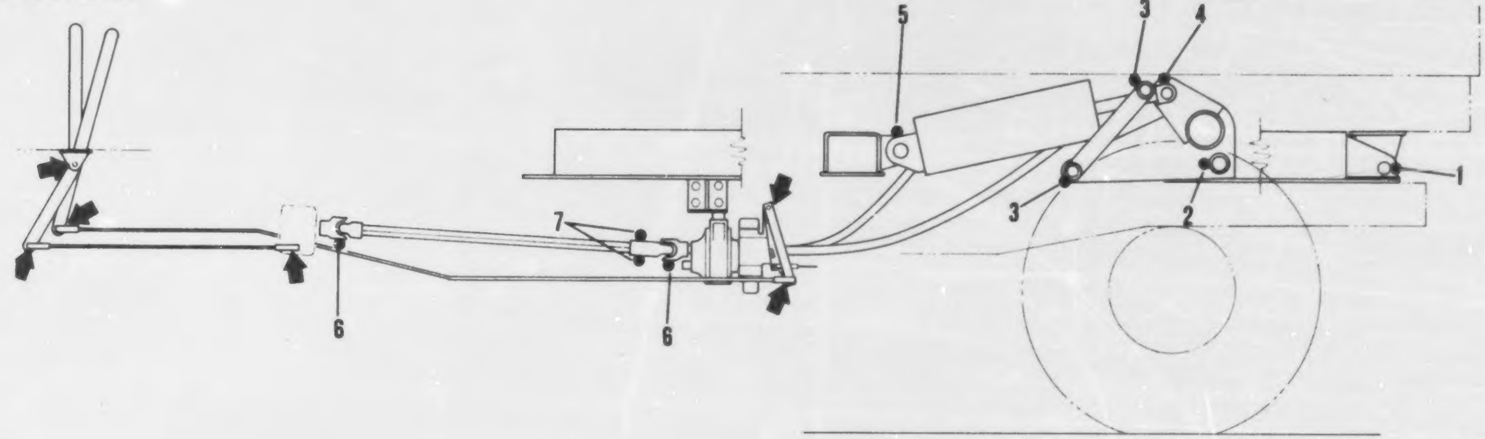
(NOTE: Proper lubrication means applying the grease in a sufficient amount and in the proper places. The experienced equipment operator uses neither too much nor too little lubricant.)

D. Wipe excess grease from fittings and any spills from floor

E. Repeat steps A-D until all fittings have been greased

JOB SHEET #4

FIGURE 18



Lubrication Chart*

1) Rear Hinges	1 fitting each hinge
2) Lever Arm	2 fittings
3) Link	2 fittings each link
4) Cylinder - Upper End	1 fitting
5) Cylinder - Lower End	1 fitting
6) U-Joint	1 fitting each end
7) U-Joint at Pump (Slip)	2 fittings
➡Control Linkage Oiling Points	6 Locations

*Use grease recommended by chassis manufacturer.

Used with permission of the Heil Company.

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #5--SHIFT A TEN-SPEED ROADRANGER TRANSMISSION

(It is assumed that the driver is familiar with trucks, and that he or she can coordinate the necessary movements of the shift lever and clutch pedal. Roadranger is one of the most commonly used transmission units. Other manufacturers may use a twelve-speed system. In that case, follow manufacturer's directions for gearshift placement. The basic steps in shifting will be the same.)

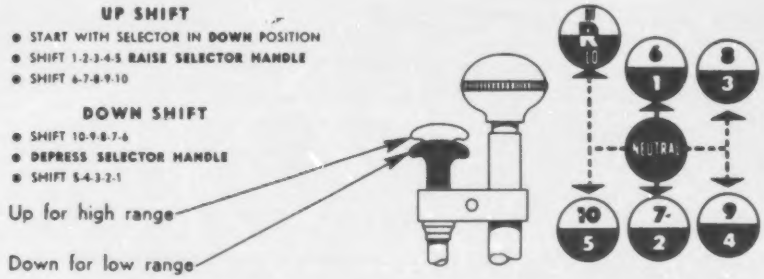
I. Equipment and materials

A. Two-speed truck equipped with Roadranger transmission

B. Manufacturer's gearshift pattern diagram (Figure 19)

(NOTE: This may be mounted on dash or imprinted on gearshift.)

FIGURE 19



UP SHIFT

- START WITH SELECTOR IN DOWN POSITION
- SHIFT 1-2-3-4-5 RAISE SELECTOR HANDLE
- SHIFT 6-7-8-9-10

DOWN SHIFT

- SHIFT 10-9-8-7-6
- DEPRESS SELECTOR HANDLE
- SHIFT 5-4-3-2-1

Used with permission of the Washington State Department of Transportation.

II. Procedure for upshifting

A. Move gearshift lever to neutral position

B. Start engine

C. Wait for air system to reach normal line pressure

D. Check range control button

(NOTE: If button is *up*, push it to the down position to shift into low range; if button is *down*, it is already in low range and should stay there.)

E. Depress clutch; shift into first gear, and drive

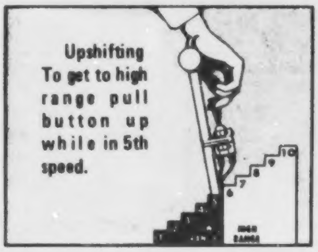
(CAUTION: Always start vehicle moving in first speed gear.)

JOB SHEET #5

F. Shift progressively through second, third, and fourth to fifth at manufacturer's recommended rpm

(NOTE: When in fifth gear, get ready for the next upward shift by locating the range control button with your hand. See Figure 20.)

FIGURE 20


Upshifting
To get to high range pull button up while in 5th speed.
1
2
3
4
5
6
7
8
9
10
HIGH RANGE

Used with permission of the Washington State Department of Transportation.

G. While in fifth, *pull* range control button *up* and move lever to sixth speed

(NOTE: As the lever passes through the neutral position, the transmission will automatically shift from low range to high range.)

H. Shift progressively through seventh, eighth, and ninth speeds to tenth speed

III. Procedure for downshifting

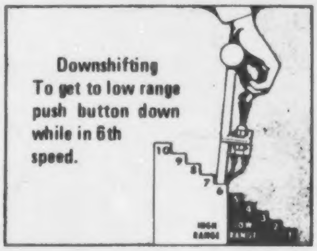
A. Move lever from tenth through each successive lower speed to sixth

(NOTE: When in sixth gear, get ready for the next downshift by locating the range control button with your hand.)

B. While in sixth, *push* range control button *down*, and move lever to fifth speed (Figure 21)

(NOTE: As the lever passes through the neutral position, the transmission will automatically shift from high range to low range.)

FIGURE 21


Downshifting
To get to low range push button down while in 6th speed.
10
9
8
7
6
5
4
3
2
1
HIGH RANGE
LOW RANGE

Used with permission of the Washington State Department of Transportation.

JOB SHEET #5

C. Shift downward through each of the four remaining speeds

(CAUTION: Never shift from high range to low range at high speeds. Never make range shifts with the vehicle moving in reverse gear. Always park vehicle with axle in low position.)

TRUCKS AND ATTACHMENTS
UNIT VIII

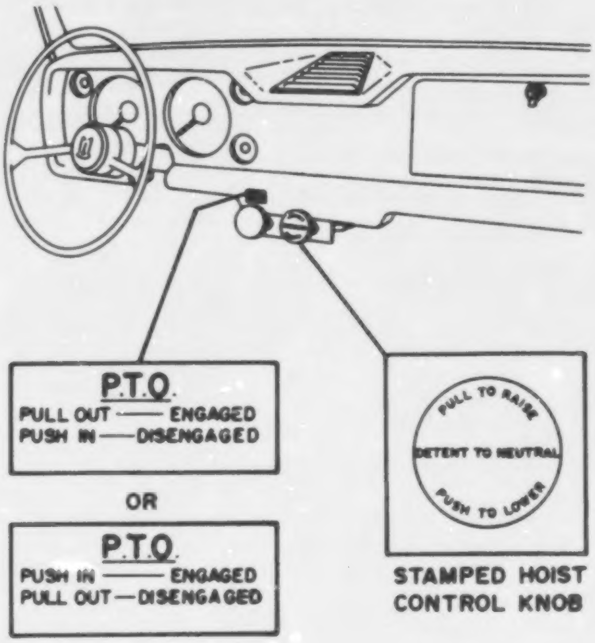
JOB SHEET #6--ENGAGE POWER TAKEOFF

I. Equipment

- A. Single-axle or tandem-axle dump truck
- B. Operator's manual

II. Procedure for standard transmission (Figure 22)

FIGURE 22


P.T.O.
PULL OUT —— ENGAGED
PUSH IN —— DISENGAGED
OR
P.T.O.
PUSH IN —— ENGAGED
PULL OUT — DISENGAGED
PULL TO RAISE
DETENT TO NEUTRAL
PUSH TO LOWER
STAMPED HOIST
CONTROL KNOB

PTO Knob Control

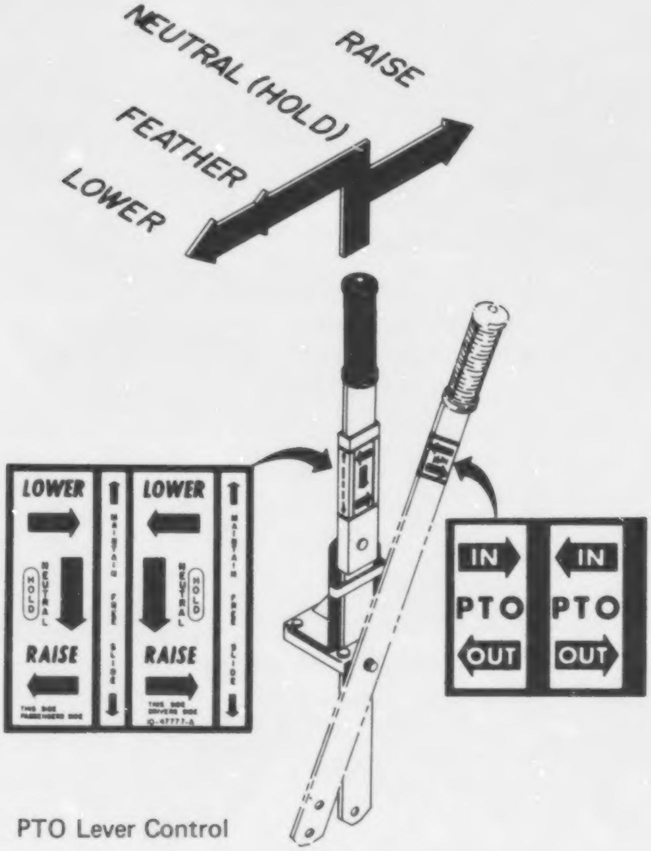
Used with permission of the Peabody International Corporation.

- A. Set emergency brake
- B. Place gearshift in neutral
- C. Depress clutch

JOB SHEET #6

D. Pull power takeoff knob toward you *or* operate lever according to instructions (Figure 23)

FIGURE 23


NEUTRAL (HOLD)
RAISE
FEATHER
LOWER
LOWER
RAISE
LOWER
RAISE
IN
PTO
OUT
IN
PTO
OUT

PTO Lever Control

Used with permission of the Peabody International Corporation.

E. Release clutch

III. Procedure for automatic transmission

A. Set emergency brake

B. Shift transmission lever into any one of the drive positions

(NOTE: This will stop transmission gears from turning.)

C. Shift power takeoff control to engage power takeoff

JOB SHEET #6

D. Shift transmission lever into neutral

(NOTE: This will start transmission gears turning, and put the power takeoff into operation.)

(CAUTION: Always disengage the PTO when hoist is not in use or when moving vehicle.)

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #7--HINGE A TAILGATE

I. Equipment

A. Dump bed

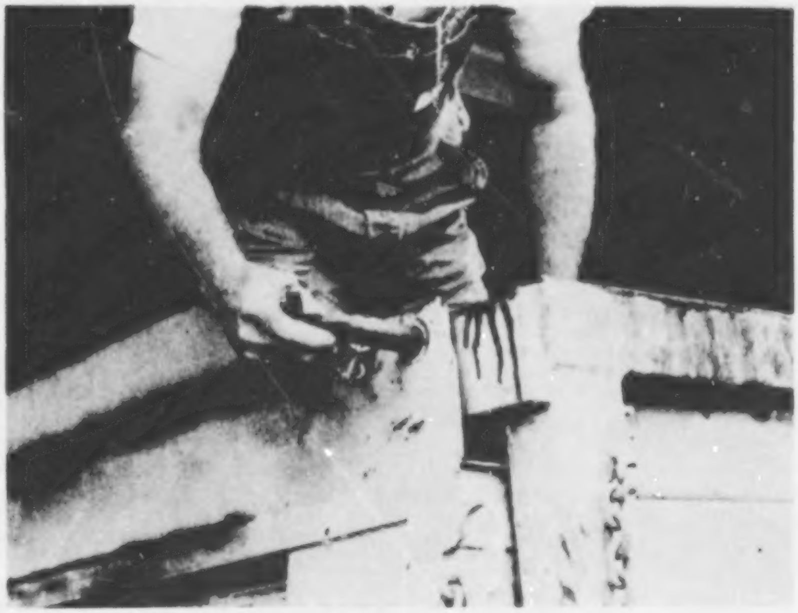
B. Tool for driving pins

II. Procedure for hinging and releasing top of tailgate

A. Align holes in truck mounting with holes in tailgate prongs

B. Insert pins (Figure 24)

FIGURE 24



C. Release by pulling pins out one at a time

(NOTE: The load puts pressure on the tailgate, and removing pins is difficult. Walk around the front of the truck to remove the second pin.)

(CAUTION: Do not walk behind tailgate after first pin has been removed.)

JOB SHEET #7

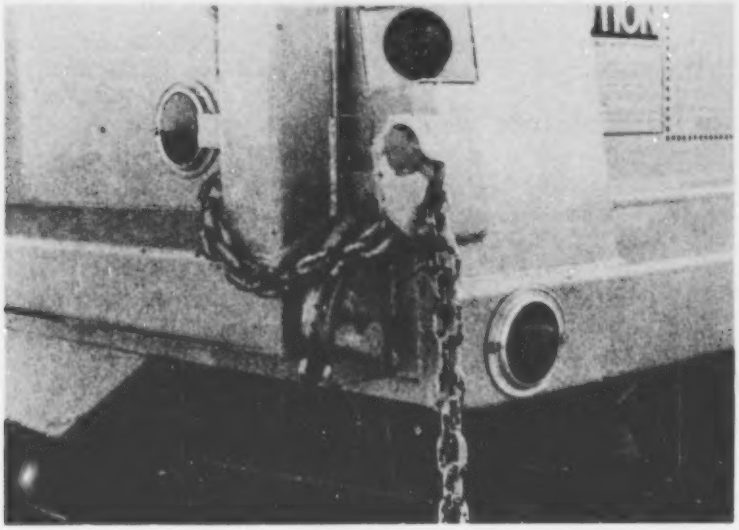
III. Procedure for hinging or hobbling bottom of tailgate

(NOTE: Width of opening is set by adjusting chains bolted to bed. Tailgate is opened or closed with tailgate latch mounted on the bed.)

A. Determine length of chain needed for width of tailgate opening

B. Insert chain into slotted clip on tailgate (Figure 25)

FIGURE 25



C. Insert same amount of chain into slotted clip on the other side

(NOTE: Count links to get equal length of chain on both sides.)

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #8--OPERATE A HOIST AND DUMP BED

I. Equipment--Hydraulic dump truck

II. Procedure

(CAUTION: Be certain the vehicle is properly and securely braked before operating hoist.)

A. Set emergency brake

B. Adjust tailgate for load release according to material to be dumped

EXAMPLES: For spreading fine sand, hobble tailgate at bottom to approximately 4 inches for a slow release

For dumping rocks or large solids, secure bottom hinge, unfasten top, and release load all at once.

C. Shift to neutral

(NOTE: For automatic transmission, put in drive gear.)

D. Depress clutch and engage power takeoff

E. Depress accelerator to raise bed at appropriate rate

(NOTE: Appropriate rate of lift depends on the type of job, such as spreading, dumping, feeding a hopper, and the type of materials and condition of materials, such as wet or dry.)

F. Move valve control knob or lever to RAISE position. When bed is at desired angle, push knob or lever in partway to neutral (HOLD) position

G. Release tailgate latch

H. To lower an empty bed, push valve control knob or lever in all the way

(CAUTION: Be sure you lower the bed after the dump.)

I. To lower a loaded or partially loaded bed, *ease* knob in

J. Disengage PTO

K. Fasten tailgate latch

(CAUTION: Be sure you lower the bed after the dump.)

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #9--PROP A DUMP BED

(NOTE: Some truck beds are equipped with bed props. Sample instructions are provided for pin-type and fulcrum-type props. For beds without such equipment, two alternative procedures are provided.)

I. Materials and equipment

   A. Truck with dump bed and attached props (pin or fulcrum type)

   B. Manufacturer's instructions for attached props

   C. Blocking materials

      1. Railroad tie or timber 6" x 6" x 5'

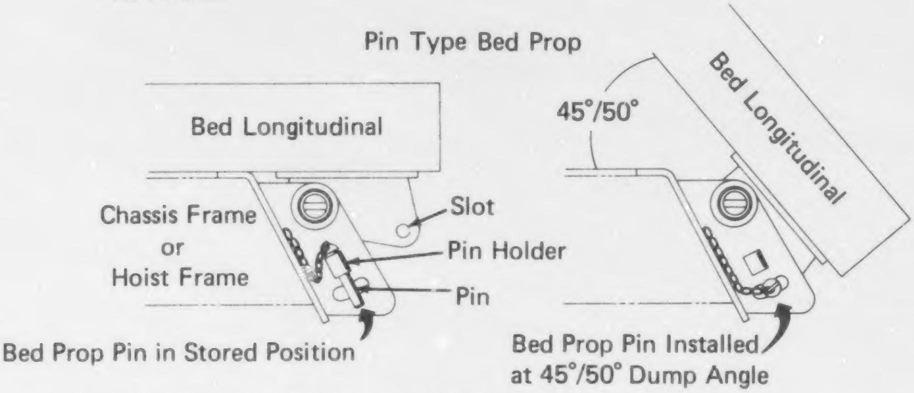
      2. Two 4" x 4" x 5' boards or timbers

II. Procedure for pin-type bed prop (Figure 26)

(CAUTION: Be sure bed is unloaded before using props.)

FIGURE 26

Pin Type Bed Prop


Bed Longitudinal
Chassis Frame or Hoist Frame
Slot
Pin Holder
Pin
Bed Prop Pin in Stored Position
45°/50°
Bed Longitudinal
Bed Prop Pin Installed at 45°/50° Dump Angle

Used with permission of Peabody International Corporation.

   A. Raise bed 45 to 50 degrees

   B. Place hoist control valve in the neutral (HOLD) position

   C. Remove pins from holders and insert through slots and rear hinge assembly on both ends of rear cross member assembly

   D. Visually inspect to see that pins are installed all the way through

   E. Lower bed slowly until it comes to rest on the prop pins

JOB SHEET #9

F. Inspect to see that pins are installed properly before performing any work

(CAUTION: Do not stand under raised bed until it is securely blocked. Do not power hoist down.)

G. To store prop, raise bed sufficiently to take load from pins; be sure hoist control valve is in neutral (HOLD) position

H. Remove pins from both sides and store in holders

(CAUTION: Before lowering bed be certain that the area is clear.)

III. Procedure for fulcrum-type bed prop (Figure 27)

(CAUTION: Be sure bed is unloaded before using props.)

A. Raise bed to height where prop(s) can be swung upward into position

B. Place hoist control valve in neutral (HOLD) position

C. Swing prop(s) up to support position

D. Lower bed slowly until prop(s) rests on prop receiver

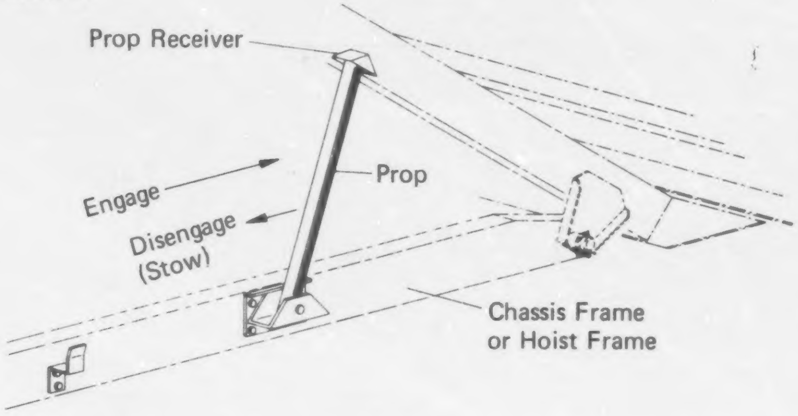
(CAUTION: Do not power hoist down.)

E. To store, raise bed to height where prop(s) will clear prop receiver; be sure hoist control valve is in neutral (HOLD) position

F. Swing prop(s) down to transit position

(CAUTION: Before lowering bed, be certain the area is clear.)

FIGURE 27



Used with permission of Peabody International Corporation.

JOB SHEET #9

IV. Procedure for railroad tie or single timber prop

(CAUTION: Be sure bed is unloaded before using prop.)

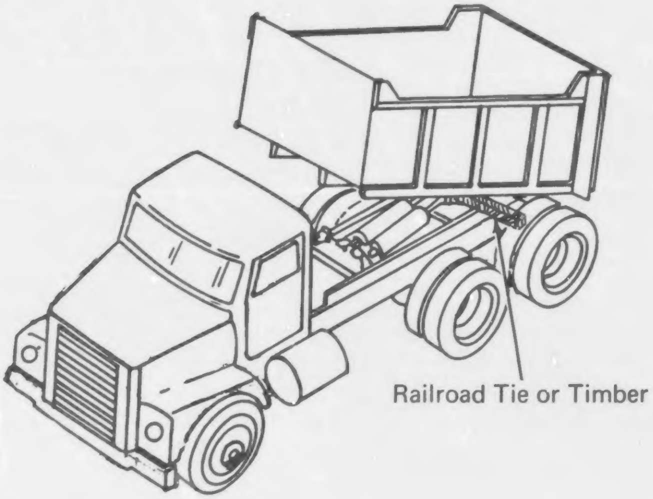
A. Raise bed

B. Insert railroad tie or timber between bed and frame over the rear axle to extend approximately one foot past each slide of the frame

C. Slowly lower bed until it rests on railroad tie (Figure 28)

(CAUTION: Do not stand under raised bed until it is blocked.)

FIGURE 28



Used with permission of the Heil Company.

JOB SHEET #9

V. Procedure for 4-by-4-inch prop

(CAUTION: Be sure bed is unloaded before using props.)

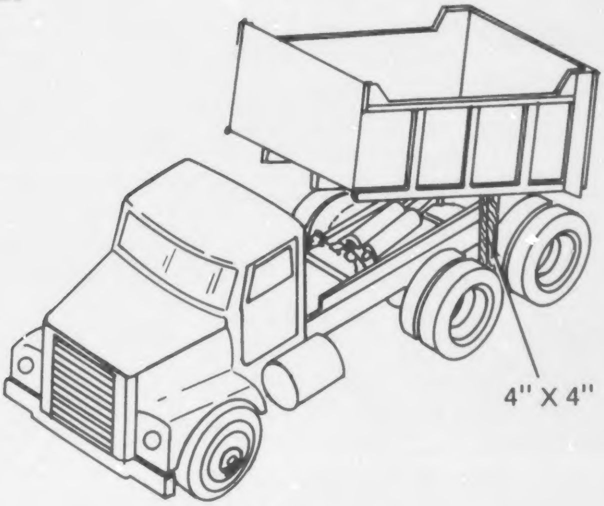
A. Raise bed

B. Place two 4-by-4-inch boards between tandem tires and block securely against body understructure

(CAUTION: Do not stand under raised bed until it is securely blocked.)

C. Slowly lower bed until it rests on the props (Figure 29)

FIGURE 29



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TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #10--BACK A DUMP TRUCK INTO A SPECIFIC POSITION

I. Equipment and personnel

  A. Single-axle or tandem-axle dump truck

  B. Spotter

  C. Marked position

  EXAMPLES: Barricades, cones, drums, painted lines, lane markers

II. Procedure

  A. Perform all prestart inspection and maintenance procedures

  B. Mount truck properly

  (NOTE: Do not grab steering wheel when climbing into truck.)

  C. Take position in driver's seat and fasten seat belt; make sure emergency brake is on

  D. Perform all starting and warm-up procedures

  E. Notify spotter that you are ready to back up

  F. Check area around truck

    1. Wait for spotter's go-ahead *or*

    2. Get out and walk around truck

  G. Signal other workers

  (NOTE: Most trucks are equipped with automatic backup warning devices. If truck is not equipped, signal with three horn blasts.)

  H. Shift into reverse gear

  I. Release emergency brake

  J. Slowly back toward position

  (NOTE: Keep your eyes on the mirrors; watch spotter.)

  K. When in position, shift to neutral and set emergency brake

  L. At signal from instructor, return to original position

  M. Repeat steps F-L three times, once without spotter

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #11--ATTACH A SNOWPLOW

I. Equipment and personnel

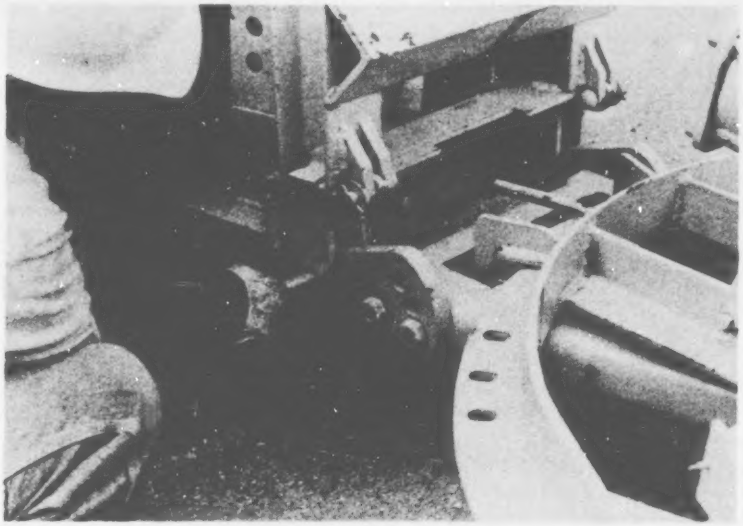
- A. Single-axle or tandem-axle truck equipped with snowplow carriage
- B. Snowplow on supports
- C. Cotter pins and clevis pins
- D. Two operators

II. Procedure

- A. Pull truck up to blade
- B. With spotter, align carriage with blade
- C. Set emergency brake
- D. Align snowplow with bracket

  (NOTE: This may take lifting or prying and is a two-person job.)
- E. Insert pin into hole (Figure 30)

FIGURE 30



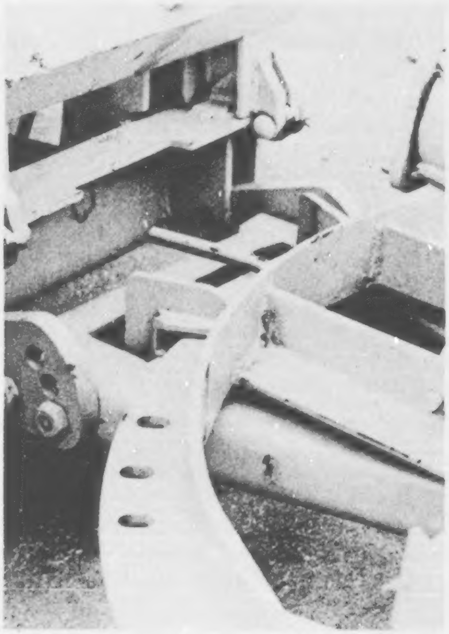
- F. Insert cotter pin

JOB SHEET #11

G. Set plowing angle by lining up holes and inserting pin (Figure 31)

(NOTE: Angle will be determined by snow conditions. The wetter the snow, the greater the angle required. Use as shallow an angle as possible for condition. The greater the angle, the smaller the plow lane.)

FIGURE 31

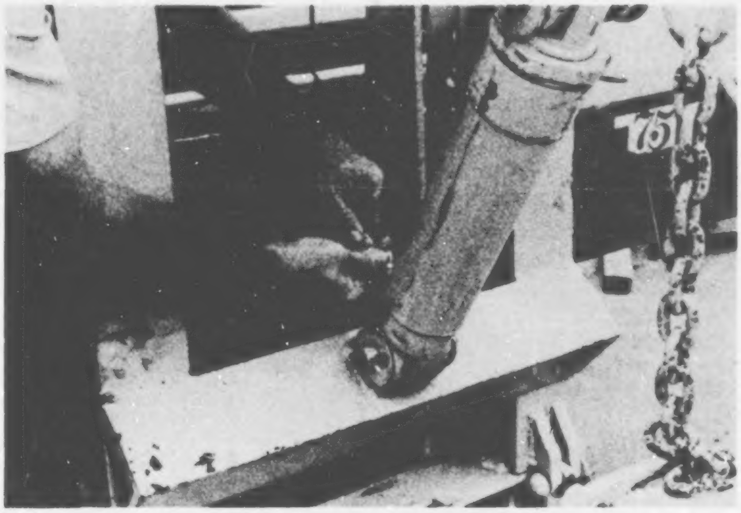


(CAUTION: If setting an acute angle, make sure wheel path is clear.)

JOB SHEET #11

H. Couple hydraulic line to lift cylinder (Figure 32)

FIGURE 32



TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #12--OPERATE A SNOWPLOW

I. Equipment--Single-axle or tandem-axle truck with trip snowplow attached

(NOTE: A trip snowplow will automatically raise when it hits an obstacle.)

II. Procedure

A. Perform all prestart inspection and maintenance procedures

B. Mount truck properly

(NOTE: Do not grab steering wheel when climbing into truck.)

C. Take position in driver's seat and fasten seat belt; make sure emergency brake is set

D. Perform all starting and warm-up procedures

E. Drive to site

(CAUTION: The raised blade has very low clearance. Drive with extreme caution.)

F. Lower blade until it touches pavement

G. Raise blade slightly to not more than one inch clearance

H. Turn on all safety warning lights

I. Drive according to road, snow, and visibility conditions

(CAUTION: Be alert for hazards.)

EXAMPLES: Bridge expansion joints, headwalls of culverts, cattle guards, signposts, guardrails, curbs, islands, raised pavement markers, fire hydrants

J. When finished, raise plow and drive to next site

III. Procedure for correcting automatic tilt

(NOTE: When blade hits an obstacle, it will automatically tilt forward, raising the blade off the ground. The operator must right the blade, replace any broken pins, and readjust for plowing. Carry extra breakaway pins in your truck at all times.)

A. Stop truck

JOB SHEET #12

B. If traffic conditions allow, back up several feet

(NOTE: The blade will straighten as it is pulled across the pavement. A spring-loaded trip or hydraulic ram trip will right itself when the blade is raised.)

C. Stop; set emergency brake

D. Get out and check pins; replace if necessary

E. Resume plowing

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #13--ATTACH A TAILGATE SPREADER

I. Equipment and personnel

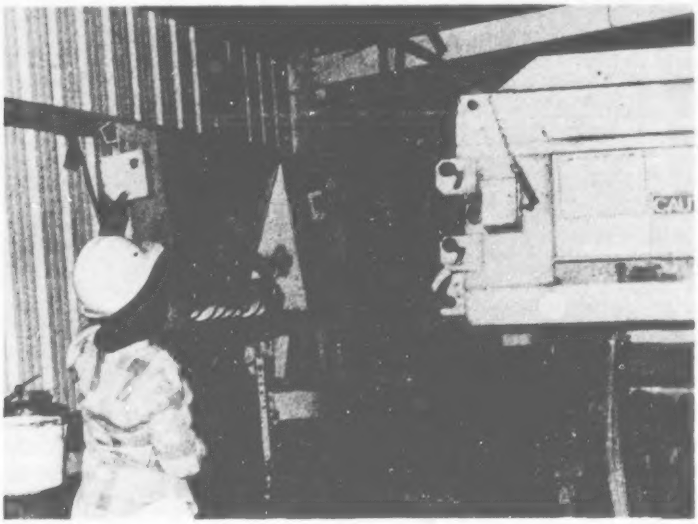
- A. Single-axle or tandem-axle truck
- B. Tailgate spreader
- C. Two operators

II. Procedure

(NOTE: On underbody spreaders, the tailgate is hinged at the top and hobbled to approximately 4 inches at bottom. On other models, tailgate must be removed.)

- A. Back up truck to hanging spreader attachment (Figure 33)

FIGURE 33



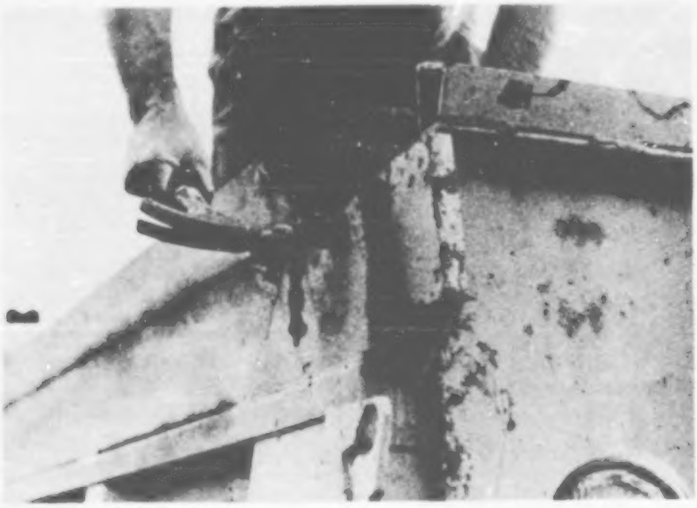
- B. Align spreader so that eyelets line up with eyelets on truck, and bottom rod is lined up with catch

  (NOTE: Raise the bed until spreader and truck are lined up.)

- C. Be sure spreader is firmly seated on bed and correctly aligned

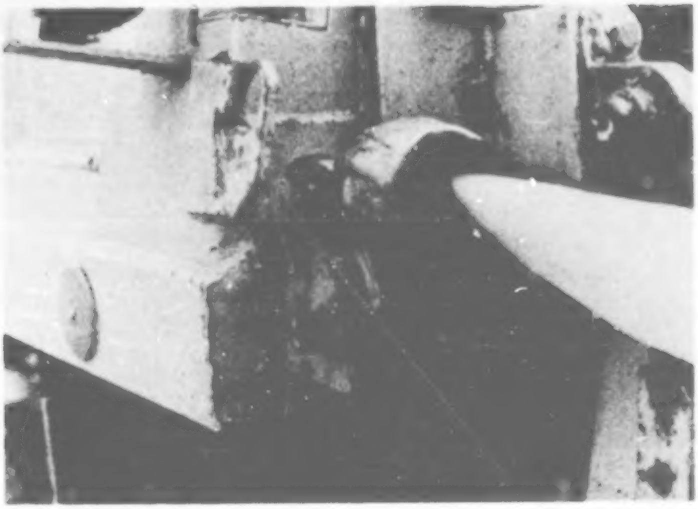
D. Drive pins through holes (Figure 34)

FIGURE 34



E. Fasten latch (Figure 35)

FIGURE 35



F. Attach stay chains if provided

G. Connect hydraulic lines; be sure couplings are secure

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #14--OPERATE A TAILGATE SPREADER

I. Equipment

   A. Single-axle or tandem-axle truck with tailgate spreader attached

   B. Load of sand, sand and salt, or other abrasive material

II. Procedure

   A. Make a visual inspection for worn, broken, loose or missing parts, or leaks

   B. Make any necessary minor repairs or adjustments

   C. Mount truck properly

   (NOTE: Do not grab steering wheel when climbing into truck.)

   D. Take position in driver's seat and fasten seat belt; make sure emergency brake is set

   E. Perform all starting and warm-up procedures

   F. Drive to spreading site

   G. Select appropriate gear range

   H. Engage PTOs

   (NOTE: Some trucks are equipped with one PTO for both the bed and the spreader; most have two separate PTOs. Engage both.)

   I. Raise bed

   J. Engage spreader clutch if using sprocket-type drive

   (NOTE: Location of this lever or button will vary from truck to truck.)

   K. Release emergency brake

   L. Drive forward slowly

   M. Check distribution in rearview mirror

   N. Adjust speed to correct distribution rate

   (NOTE: Speed will usually be from 15 to 20 mph.)

JOB SHEET #14

O. Raise bed *gradually* as material flows

(NOTE: If bed is raised too quickly, material will spill, be wasted, and will have to be shoveled back into bed.)

(CAUTION: Never raise bed all the way until it is completely empty.)

P. At end of spreading section, lower bed

Q. Disengage spreader clutch

R. Disengage PTO(s)

S. Proceed to next site

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #15--OPERATE A HOPPER SPREADER

I. Equipment, materials, and personnel

  A. Truck with hopper spreader mounted on chassis

  (NOTE: Hopper spreader can also be mounted in dump truck beds. See operator's manual for attaching instructions.)

  B. Operator's manual

  C. Loader

  D. Loader operator

  E. Stockpile of salt or sand and salt combined

  F. Tool box

  G. Four 4" x 4" x 18" wood blocks

  H. Safety equipment

    1. Hard hat
    2. Warm head covering
    3. Gloves
    4. Warm, close-fitting clothing and warm boots

II. Procedure

  A. Make a visual inspection for worn, broken, loose or missing parts, or leaks

  B. Make any necessary minor repairs or adjustments

  C. Set baffle plates so that the spread of material will be approximately 12 feet wide

  D. Mount truck properly

  (NOTE: Do not grab steering wheel when climbing into truck.)

  E. Take position in driver's seat and fasten seat belt; make sure emergency brake is set

  F. Perform all starting and warm-up procedures

  G. Engage PTO to activate hydraulic pump

JOB SHEET #15

H. Set hydraulic control valves to ON position to test the conveyor belt and distributor disc (spinner) for proper functioning

I. Turn hydraulic control valves for spinner and conveyor belts off

J. Disengage PTO to hydraulic pump

K. Release emergency brake

L. Drive unit to stockpile so that hopper can be loaded

M. Set emergency brake during loading operation

N. When loading is completed, release emergency brake and drive to work area

O. Turn on all warning and safety devices

P. Merge with traffic and engage PTO for hydraulic pump

Q. Set valve for distributor disc (spinner) to ON

R. Set conveyor belt valve to ON

S. Travel at 25 to 45 mph

(NOTE: Speed will be determined by weather, road location, and conditions.)

T. Observe spread of material; adjust baffle plates if needed

U. Continue spreading full distance in this direction

V. Set conveyor belt valve to OFF

W. Set spinner valve to OFF

X. Turn truck around and repeat steps P through I until job is completed, reloading hopper as necessary

Y. Set conveyor and spinner valves to OFF

Z. Drive spreader to yard

AA. Set emergency brake and perform shut-down procedures

BB. Dismount properly

CC. Block rear wheels, both front and back

DD. Make final visual inspection for broken, worn, loose, or missing parts, or leaks

(NOTE: Write down all deficiencies and report to proper authority.)

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #16--COUPLE AND UNCOUPLE A TRAILER

I. Equipment and personnel

   A. Single-axle or tandem-axle truck with hitch

   B. Trailer and attachment, with tongue blocked up off ground

   C. Wheel blocks

   D. Jack, if needed

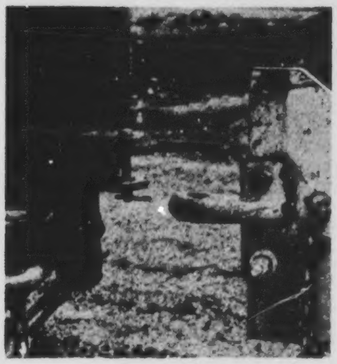
   E. Spotter

   F. Cotter pins

II. Procedure for coupling

(NOTE: Procedure for tongue and groove hitch is given; coupling procedures are essentially the same for all types of hitches. See Figures 36-38 for several other commonly used hitches.)

FIGURE 36



Tongue and Groove

FIGURE 37

Military Hitch

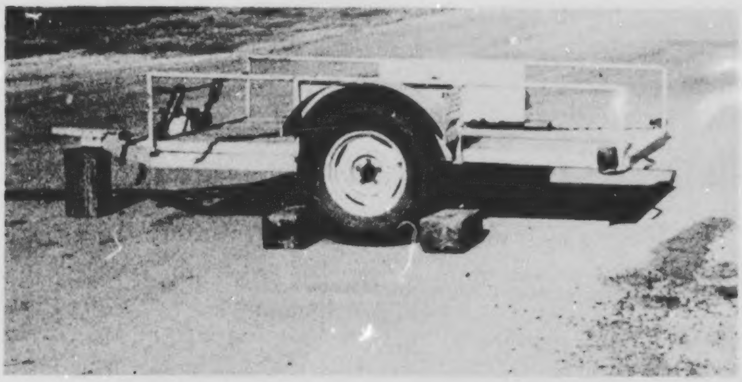
FIGURE 38

Ball and Socket

JOB SHEET #16

A. Block trailer wheels (Figure 39)

FIGURE 39



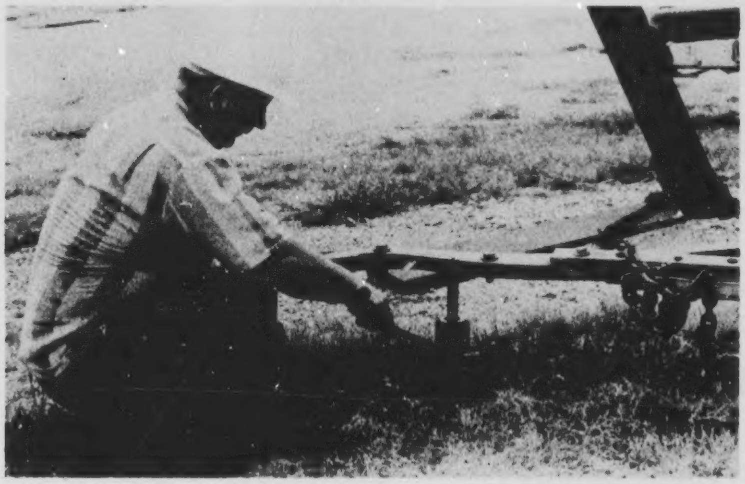
B. Watch spotter and back truck up to trailer, aligning tongue and hitch

C. Set emergency brake

D. If needed, set jack under trailer tongue forward of center of tongue; raise jack (Figure 40)

(NOTE: Follow manufacturer's instructions for operating jack.)

FIGURE 40



JOB SHEET #16

E. Release truck emergency brake

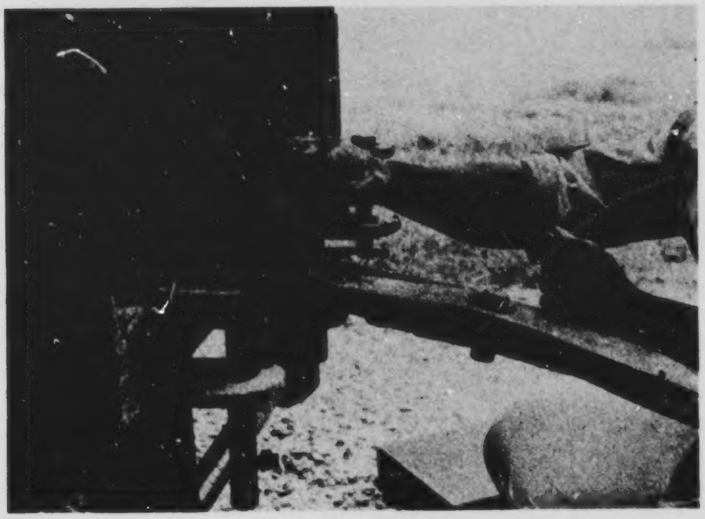
F. Ease truck back so that parts are aligned

G. Set emergency brake

H. Lower jack until parts intersect or fit

I. Insert clevis pin through holes (Figure 41)

FIGURE 41

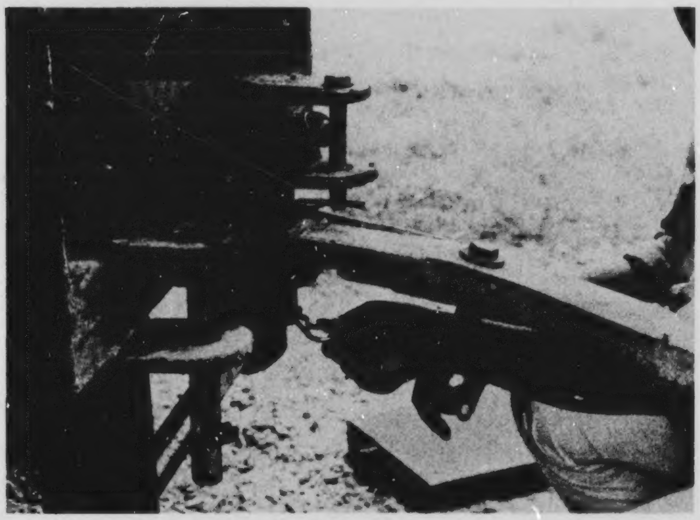


JOB SHEET #16

J. Insert cotter pin (Figure 42)

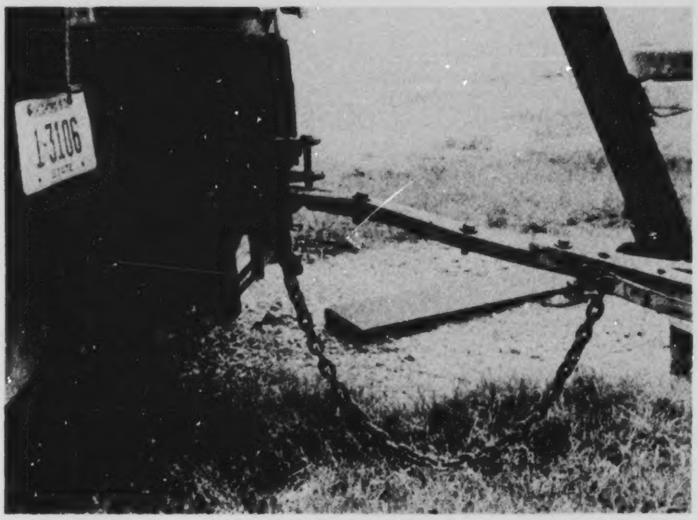
(NOTE: If hitch uses a drilled pin, secure it with a cotter key. If hitch is ball and socket type, be sure locking lever is pushed down and secured with a drilled pin through the holes; the pin is secured with a cotter key. If hitch is spring-loaded type, make sure the keeper is completely closed.)

FIGURE 42



K. Connect safety chains to complete coupling (Figure 43)

FIGURE 43



JOB SHEET #16

L. Lower and remove jack

M. Remove blocks

(NOTE: Carry blocks in truck for emergency uncoupling.)

III. Procedure for uncoupling

A. Set emergency brake

B. Block trailer wheels

C. Set block under tongue

D. If needed, set jack under tongue and raise jack to just touch tongue

(NOTE: Do not raise jack any higher.)

E. Disconnect safety chains

F. Remove cotter pin; lift clevis pin out

G. Slowly raise jack until parts will clear each other

H. Release truck emergency brake

I. Move truck forward

J. Set brake

K. Replace pins in hitch

L. Slowly lower jack until tongue rests on block

TRUCKS AND ATTACHMENTS
UNIT VIII

JOB SHEET #17--BACK A TRAILER

I. Equipment and personnel

- A. Single-axle or tandem-axle truck
- B. Marked lane or parking area having drums, barricades, stripes, or cones
- C. Spotter

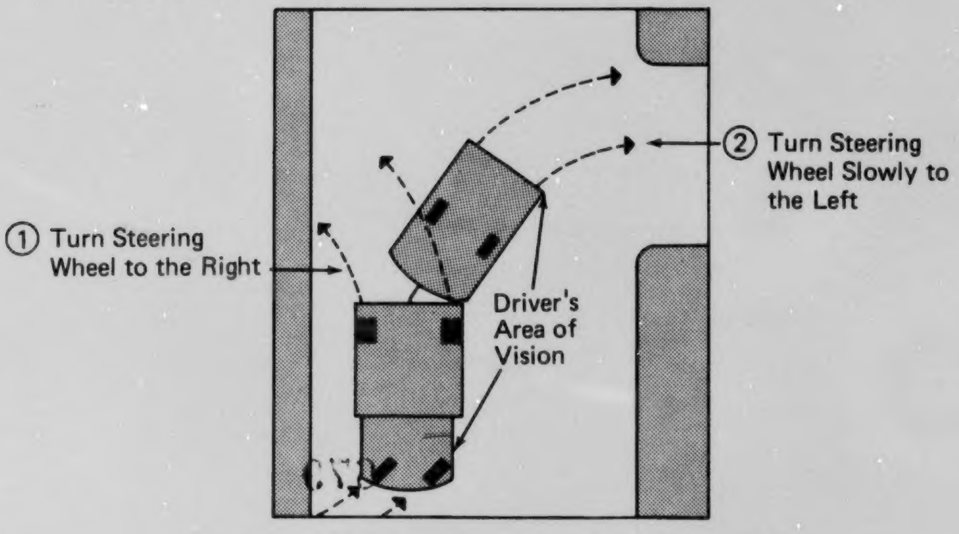
II. Procedure

(NOTE: Reverse procedure used to back a straight truck.)

- A. Notify spotter
- B. Put truck in reverse gear and begin backing slowly
- C. Turn steering wheel right to back to the left (sight side)
- D. After trailer is headed in desired direction, turn steering wheel slowly to left (Figure 44)

  (NOTE: This puts the truck in same line of travel as trailer and prevents truck and trailer from jackknifing.)

FIGURE 44


② Turn Steering Wheel Slowly to the Left
① Turn Steering Wheel to the Right
Driver's Area of Vision

BACKING A TRAILER TO THE LEFT (SIGHT SIDE)

(CAUTION: Use "sight side" backing whenever possible. It is safer.)

JOB SHEET #17

E. After successfully backing to left, pull forward and back to right

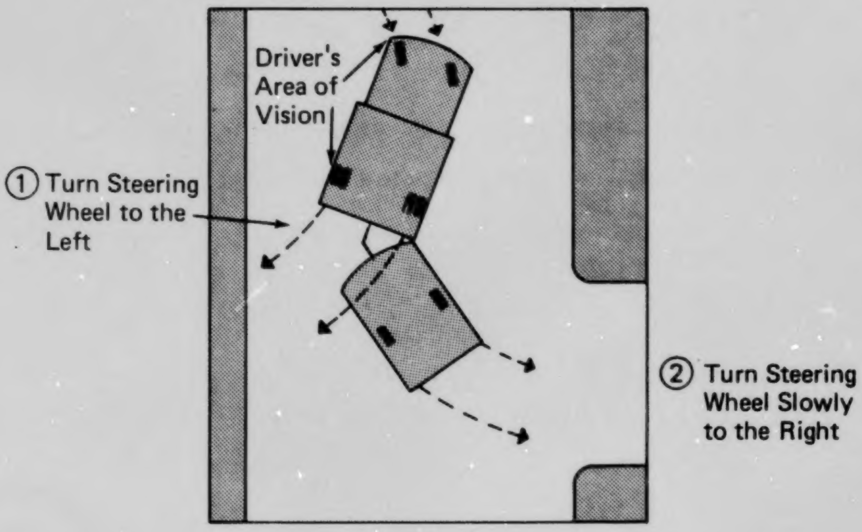
F. Notify spotter

G. Put truck in reverse; begin backing slowly

H. Turn steering wheel to left

I. After trailer is headed in the desired direction, turn steering wheel slowly to the right (Figure 45)

FIGURE 45


Driver's Area of Vision
① Turn Steering Wheel to the Left
② Turn Steering Wheel Slowly to the Right

BACKING A TRAILER TO THE RIGHT (BLIND SIDE)

(CAUTION: Use a spotter for "blind side" backing. Use this type of backing only when absolutely necessary.)

J. Repeat steps A-I twice

TRUCKS AND ATTACHMENTS
UNIT VIII

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with trucks and attachments to their correct definitions. Write the correct numbers in the blanks. Terms and definitions are continued on the following page.

_____a. Device for automatic control of speed, pressure, or temperature

_____b. Pressure in pounds per square inch

_____c. Towed vehicle which rests on its own wheels

_____d. To restrict movement of a hinge

_____e. Revolutions per minute

_____f. Protects truck cab from falling rocks and load shift

_____g. Ridge of loose material (also called a "wrinkle")

_____h. Extension from a towed vehicle which can be connected to a truck or tractor

_____i. Geared device which rotates two axles or shafts and allows them to turn at different speeds

_____j. Mechanical connection on an engine or transmission to which a cable, belt, or shaft can be connected to drive an attachment or tool

_____k. Condition in which truck and trailer become jammed together at an acute angle

_____l. Open storage bin

_____m. Controllable device which connects or disconnects two parts of the transmission which revolve in line with each other

_____n. Twisting or turning force exerted on a shaft

_____o. Device that disconnects differential and turns both rear axles at same speed

_____p. Double-axle drive unit

1. Jackknife
2. Torque
3. Power takeoff (PTO)
4. Hobble
5. Cab guard
6. Tongue
7. Trailer
8. Windrow
9. Clutch
10. psi
11. Governor
12. rpm
13. Differential (third member)
14. Lockout
15. Hopper
16. Tandem

TEST

_____q. Ground that forms an incline

_____r. Toothed gear that meshes with a drive chain

_____s. Hydraulic or mechanical lifting device

_____t. Device used to develop pressure in the transfer of fluids

_____u. Storage tank

_____v. Powered or moved by liquid under pressure

_____w. Connection which allows a swinging or pivotal motion in one plane

_____x. Pin or pivot mounted on bearings; used to rotate or tilt an object

_____y. Effect produced when engine is overloaded

_____z. Rotating drill with screw thread that carries material away from face of drill

_____aa. Load that results when material being dumped does not flow evenly from dump bed

17. Hinge
18. Jack
19. Pump
20. Reservoir
21. Sprocket
22. Hydraulic
23. Lug
24. Auger
25. Split load
26. Trunnion
27. Slope

2. Select from the following list duties and responsibilities of the truck driver. Write an "X" in the blank before each correct answer.

_____a. Treat mechanics as your friends

_____b. Leave maintenance to the next person on shift

_____c. Make complete inspection of your unit before trip; do not leave until everything is in good working order

_____d. Avoid abusing the truck in any way

_____e. Run engine at maximum rpm when possible

_____f. Never make derogatory remarks about equipment or highway department

_____g. Learn to recognize equipment defects immediately; report symptoms to the proper authority as soon as possible

_____h. Perform daily or shift maintenance

_____i. Complain to supervisor about work hours

TEST

______j. Promote good public relations

______k. Handle all road failures strictly according to departmental policies; report to proper authority

______l. Avoid public contact

3. State ten safety rules for driving a truck.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

4. Match single-axle and tandem-axle trucks and attachments to their correct uses. Write the correct numbers in the blanks.

______a. Used to haul light loads, remove snow, and pull small trailers

______b. Used to spread abrasives on icy roadways (usually sand, sand and salt, chips, or cinders)

______c. Used to haul equipment

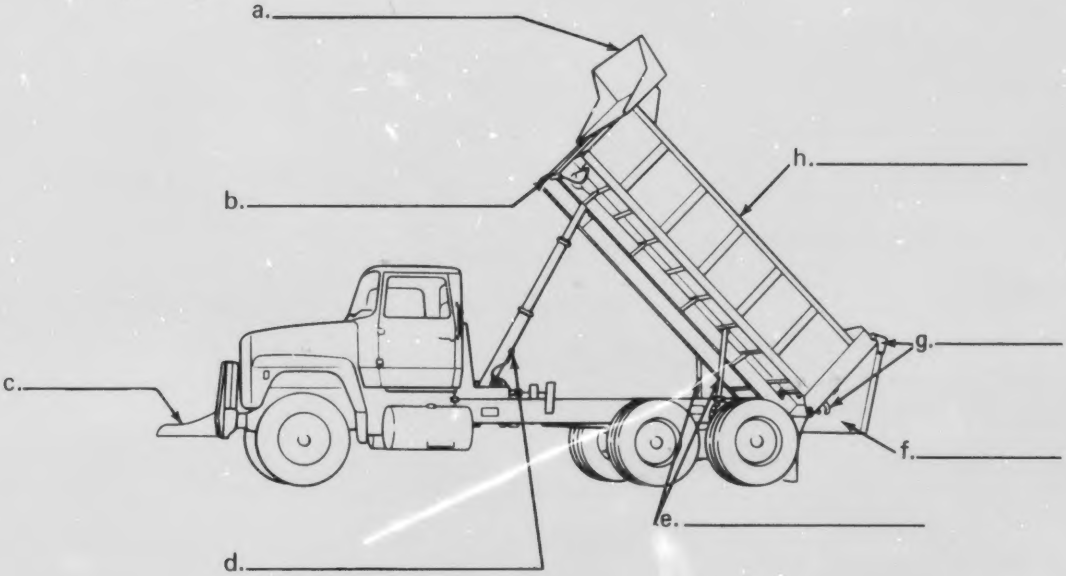
______d. Used to remove snow from roadway

______e. Used to haul heavy loads, remove snow, and pull small trailers

1. Tandem-axle truck
2. Snowplow
3. Tilt trailer
4. Single-axle truck
5. Chip spreader

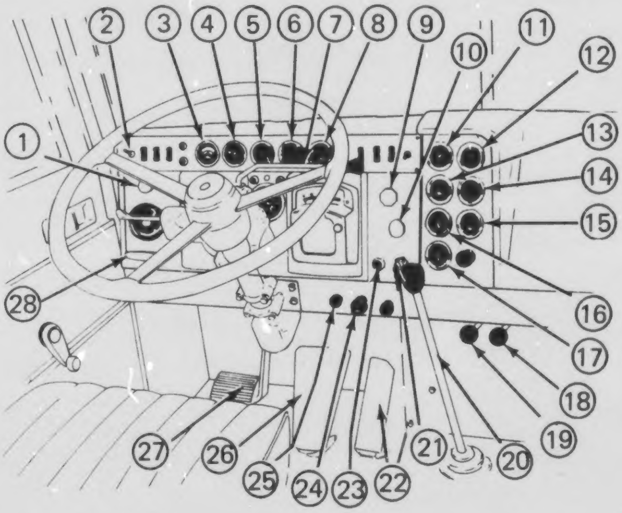
TEST

5. Label parts of a dump truck. Write the correct names in the blanks.



TEST

6. Identify truck cab controls. Write the correct numbers in the blanks.



______a. Trailer brake hand control valve

______b. Air pressure application gauge

______c. Emergency engine kill

______d. Ignition switch

______e. Fuel level gauge

______f. Oil pressure gauge

______g. Auxiliary transmission oil temperature gauge*

______h. Hydraulic hoist control

______i. Forward rear axle oil temperature gauge*

______j. Ammeter

______k. Rear rear axle oil temperature gauge*

______l. Starting button

______m. Clutch pedal

______n. Water temperature gauge

______o. Parking brake control

______p. Power takeoff

______q. Throttle control

______r. Trailer protection valve control

______s. Brake pedal

______t. Transmission shift control lever

______u. Exhaust brake switch

______v. Air pressure gauge

______w. Differential lockout*

______x. Transmission oil temperature gauge

______y. Engine oil temperature gauge

______z. Fuel pressure gauge

______aa. Accelerator pedal

______bb. Engine shutoff control

*On tandem-axle trucks only

TEST

7. Match truck cab controls to their correct functions. Write the correct numbers in the blanks. Controls and functions are continued on the next page.

______a. Cranks engine

______b. Selects gears

______c. Ignition key switch

______d. Indicates miles per hour

______e. Raises and lowers dump bed

______f. Stops fuel to the engine

______g. Operates drive train to power dump bed and attachments

______h. Engages or disengages the transmission

______i. Stops air flow to the engine

______j. Controls engine speed

______k. Stops or slows truck

______l. Indicates engine rpms

______m. Indicates oil temperature in auxiliary transmission

______n. Controls engine speed by hand

______o. Will brake truck by slowing engine

______p. Indicates temperature of engine oil

______q. Indicates fuel pressure at pump

______r. Registers the amount of battery charge or discharge

______s. Turns both rear axles at the same speed

______t. Indicates transmission oil temperature

______u. Indicates air pressure

______v. Used to secure truck when parked or stopped

______w. Indicates water temperature

1. Hydraulic hoist control
2. Clutch pedal
3. Emergency engine kill
4. Auxiliary transmission oil temperature gauge
5. Brake pedal
6. Tachometer
7. Power takeoff
8. Throttle control
9. Starting switch
10. Engine shutoff control
11. Starting button
12. Transmission shift control lever
13. Accelerator pedal
14. Speedometer
15. Exhaust brake switch
16. Parking brake control
17. Differential lockout
18. Transmission oil temperature gauge
19. Ammeter
20. Fuel pressure gauge
21. Air pressure gauge
22. Engine oil temperature gauge
23. Water temperature gauge

TEST

______x. Indicates oil temperature in rear rear axle

______y. Registers amount of air pressure used as brakes are applied

______z. Applies and releases parking or emergency brakes on trailer

______aa. Indicates amount of fuel in tank

______bb. Indicates oil temperature in front rear axle

______cc. Operates trailer brakes independently of the truck brakes

______dd. Indicates engine oil pressure

______ee. Opens and closes tailgate

24. Forward rear axle oil temperature gauge
25. Air pressure application gauge
26. Oil pressure gauge
27. Trailer protection valve control
28. Fuel level gauge
29. Rear rear axle oil temperature gauge
30. Tailgate latch
31. Trailer brake hand control valve

8. Select from the following list guidelines for shifting gears. Write an "X" in the blank before each correct answer.

______a. Use low range for most on-site work

______b. Use high range for most on-site work

______c. Shift gears at proper engine rpm to avoid excessive torque action

______d. Learn the gearshift pattern for each truck

______e. Shift quickly

______f. Use low range for highway driving

______g. Use high range for highway driving

______h. Get to know your truck

______i. Shift at the lowest possible rpm

9. State six procedures to extend truck life.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

TEST

10. Select from the following list procedures to extend tire life. Write an "X" in the blank before each correct answer.

______a. Maintain 35 psi pressure in each tire

______b. Lower speed on roads that have large, sharp-edged chuckholes

______c. Do not run over curbs when turning corners or parking

______d. Keep on the center "hump" on dirt roads to avoid deep pits and potholes

______e. Center vehicle in lane to avoid riding pavement edge

______f. Anticipate stops in time to avoid sliding tires

______g. Keep tires aligned so that the inside tread wears faster than the outside tread

______h. Start slowly; do not spin wheels

______i. Drive at slower speeds in hot weather

______j. Never run on soft or flat tires

______k. Check tread depth every 2,000 miles

______l. Drive at faster speeds in cold weather

______m. Report any unusual tire wear to maintenance department

______n. Maintain correct air pressure to manufacturer's specifications

______o. Drive at moderate speeds, particularly when heavily loaded in hot weather

11. Match components of an air brake system to their correct functions. Write the correct numbers in the blanks. Functions are continued on the next page.

______a. Driven by engine; furnishes compressed air to the braking system

______b. Controls amount of pressure built up by compressor

______c. Store compressed air

______d. Controls amount of compressed air going to and from brake chambers

______e. Convert compressed air into mechanical force to brake wheels; one is located at each wheel

1. Brake chambers
2. Brake valve
3. Compressor
4. Quick release valve
5. Relay valve
6. Reservoirs
7. Governor

TEST

______f. Speeds air to brake chambers when air must travel some distance from brake valve to brake chamber

______g. Speeds release of air from brake chambers

12. Select from the following list procedures for air brake operation. Write an "X" in the blank before each correct answer.

______a. Drain air tanks *daily* to release moisture from condensation

______b. Do not pump air brakes

______c. Use gears instead of brakes as much as possible when truck is loaded

______d. Ease air application as speed is reduced

______e. Do not ride air brakes

______f. Place gear in neutral position and depress accelerator when stopped in order to increase pressure

______g. Stop quickly to preserve air pressure

______h. As you start to slow down or stop, use as strong an application of air as conditions will permit

______i. Pump brakes when coming to a stop

______j. Check air pressure gauge frequently

______k. When driving downhill, use air brakes to prevent wear on the transmission

13. State ten safety precautions for operating the hoist.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

TEST

14. State ways to detect truck defects.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

15. Select from the following list factors which determine dumping procedures. Write an "X" in the blank before each correct answer.

______a. Type of job

______b. Type of road surface

______c. Type of material

______d. Weather conditions

______e. Type of attachment

______f. Condition of material

16. Select from the following list rules for backing a truck. Write an "X" in the blank before each correct answer.

______a. Always travel at maximum speed appropriate for conditions

______b. Signal before backing

______c. Practice backing with the truck loaded

______d. Use the truck wheels as line-of-sight guide

______e. Move with extreme caution

______f. Raise the bed 10 to 12 feet before arriving at dumping site

______g. Line truck up with object in front of truck

______h. Use a spotter when available

______i. Walk around truck to make sure area is clear

______j. Keep eyes on the mirrors at all times

______k. Always proceed slowly

______l. Practice backing each truck *before* loading bed

TEST

17. Select from the following list procedures for batch-plant loading. Write an "X" in the blank before each correct answer.

    ______a. Adjust or hobble tailgate for dumping *before* loading

    ______b. Secure bottom hinges only

    ______c. If loading asphaltic material, hose down bed with diesel fuel or soap solution

    ______d. Pull up under chute

    ______e. Remain in place as loading progresses

    ______f. Always stay in cab during loading

    ______g. When loading is completed, pull out just in front of the chute

    ______h. Complete necessary paperwork

    ______i. Secure tailgate, top and bottom hinges

    ______j. Watch spotter for signals to pull forward

    ______k. When loading is completed, pull well away from chute area

    ______l. Lean out of cab or window to check loading

18. List causes of dump bed tip-over.

    a. Top-heavy load

        1. ______________________________
        2. ______________________________
        3. ______________________________
        4. ______________________________

    b. Side load

        1. ______________________________
        2. ______________________________

    c. Excessive swaying movement in the chassis

        1. ______________________________
        2. ______________________________

TEST

19. Select from the following list procedures to prevent dump bed tip-over. Write an "X" in the blank before each correct answer.

_____a. If bed is loaded unevenly, get into the bed and even the load with a shovel

_____b. Reduce air pressure in the rear tires

_____c. Load from front to rear

_____d. Raise bed slowly

_____e. Make sure bed is empty and clean before loading

_____f. Keep bed washed down with diesel fuel when required

_____g. Keep bed washed down with gasoline when required

_____h. Load from both sides

20. State seven safe procedures for snow removal.

a. ____

b. ____

c. ____

d. ____

e. ____

f. ____

g. ____

21. Select from the following list hazards of snowplowing. Write an "X" in the blank before each correct answer.

_____a. Guardrails

_____b. Cattle

_____c. Temperature changes

_____d. Curbs

_____e. Bridge expansion joints

_____f. Overpasses

_____g. Signposts

TEST

______h. Sloped ramps

______i. Drums and barricades

______j. Hard-packed snow or ice

______k. Ditches

______l. Raised pavement markers

______m. Low shoulders

______n. High shoulders

______o. Pavement expansion joints

22. State procedures for effective snowplowing.

a. ____

b. ____

c. ____

d. ____

e. ____

f. ____

g. ____

23. Name snowplow angles for different snow conditions. Write the correct names in the blanks.

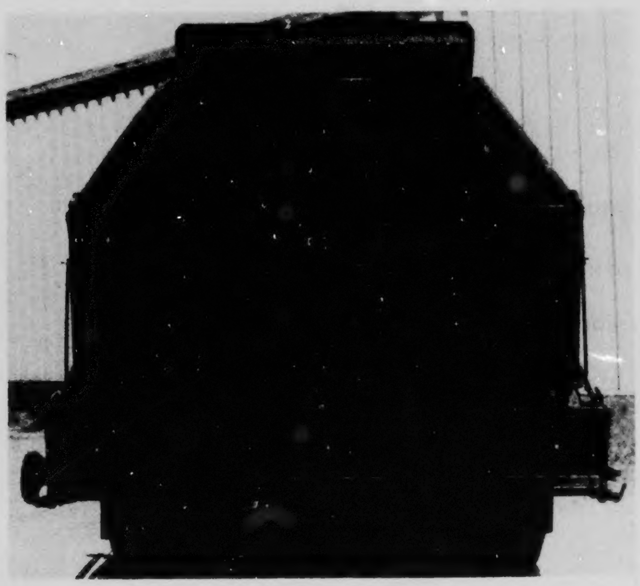
a. Light, dry snow requires ____________________ angle

b. Heavy, wet snow requires ____________________ angle

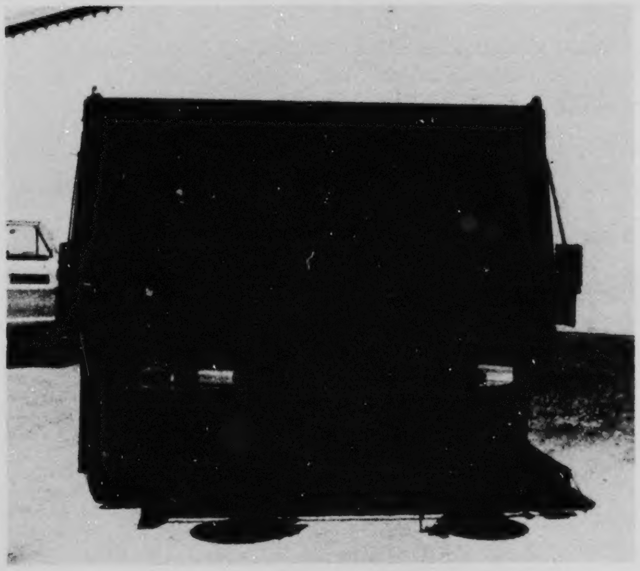
TEST

24. Identify types of spreaders. Write the correct names in the blanks.

Fan type Hydraulic type Hopper type

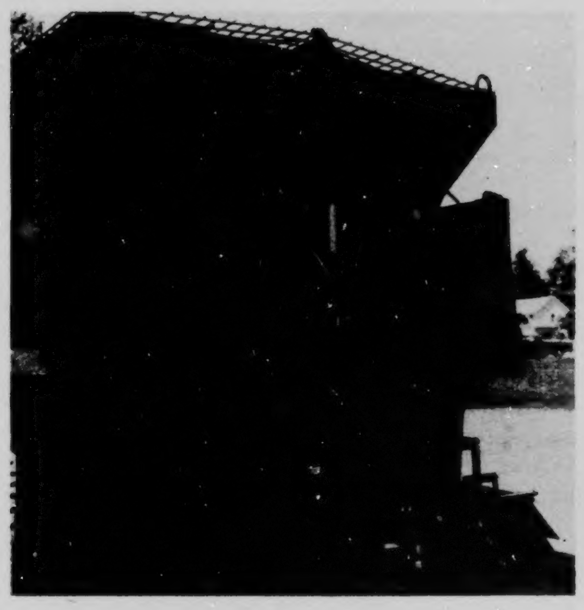


a. ______________________________



b. ______________________________

TEST



c. ______________________

25. Select from the following list guidelines for towing a trailer. Write an "X" in the blank before each correct answer.

______a. Be sure coupling is secure

______b. Increase speed to make up for added weight

______c. Allow for added length when turning, backing, and passing other vehicles

______d. Allow increased space for maneuvering truck and trailer into position

______e. Stay close to the right-hand side of the road when making a right turn

______f. Both trailer and truck must be equipped with the same type brakes

______g. Signal turns well in advance of turn

______h. Brake for a stop as close as possible to the stop

______i. Be especially cautious on icy roads

26. State guidelines for backing a trailer.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

TEST

(NOTE: Questions 27-30 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

27. Construct a plan for a snow removal operation.

28. Analyze a snowplow route for hazards.

29. Complete an equipment inspection checklist.

30. Demonstrate the ability to

    a. Perform prestart inspection and maintenance procedures.

    b. Service a truck.

    c. Start, warm up, operate, and shut down a truck.

    d. Lubricate a hydraulic hoist.

    e. Shift a ten-speed Roadranger transmission.

    f. Engage power takeoff.

    g. Hinge a tailgate.

    h. Operate a hoist and dump bed.

    i. Prop a dump bed.

    j. Back a dump truck into a specific position.

    k. Attach a snowplow.

    l. Operate a snowplow.

    m. Attach a tailgate spreader.

    n. Operate a tailgate spreader.

    o. Operate a hopper spreader.

    p. Couple and uncouple a trailer.

    q. Back a trailer.

TRUCKS AND ATTACHMENTS
UNIT VIII

ANSWERS TO TEST

1. a. 11
   b. 10
   c. 7
   d. 4
   e. 12
   f. 5
   g. 8
   h. 6
   i. 13
   j. 3
   k. 1
   l. 15
   m. 9
   n. 2
   o. 14
   p. 16
   q. 27
   r. 21
   s. 18
   t. 19
   u. 20
   v. 22
   w. 17
   x. 26
   y. 23
   z. 24
   aa. 25

2. a, c, d, f, g, h, j, k

3. Answer should include any ten of the following
   a. Read operator's manual thoroughly--know your machine
   b. Study departmental safety manual
   c. Wear hard hat and fasten seat belt
   d. Do not haul people in dump bed or on running board
   e. Never get under the dump bed when it is raised unless it is securely blocked
   f. Do not ride the clutch
   g. Keep windshield, windows, and mirrors clean at all times
   h. Grasp the door frame firmly when entering the cab
   i. Exit the cab backwards, keeping a firm grip until your feet are on the ground
   j. Never get under the truck unless the wheels are securely blocked
   k. Clean slippery materials off your shoes

ANSWERS TO TEST

l. Keep truck clean

m. Set parking brake and block wheels when parking truck

n. Drive defensively

4. a. 4
   b. 5
   c. 3
   d. 2
   e. 1

5. a. Cab guard
   b. Tailgate latch
   c. Snowplow carriage
   d. Hoist
   e. Props
   f. Tailgate
   g. Tailgate hinges
   h. Dump bed

6. a. 7
   b. 11
   c. 28
   d. 21
   e. 8
   f. 5
   g. 17
   h. 18
   i. 14
   j. 3
   k. 15
   l. 23
   m. 27
   n. 4
   o. 9
   p. 19
   q. 24
   r. 10
   s. 26
   t. 20
   u. 2
   v. 6
   w. 1
   x. 16
   y. 13
   z. 12
   aa. 22
   bb. 25

ANSWERS TO TEST

7. a. 11
b. 12
c. 9
d. 14
e. 1
f. 10
g. 7
h. 2
i. 3
j. 13
k. 5
l. 6
m. 4
n. 8
o. 15
p. 22
q. 20
r. 19
s. 17
t. 18
u. 21
v. 16
w. 23
x. 29
y. 25
z. 27
aa. 28
bb. 24
cc. 31
dd. 26
ee. 30

8. a, c, d, g, h

9. Answer should include any six of the following

a. Keep up preventive maintenance schedule
b. Allow engine to warm up before moving truck
c. Never let engine lug
d. Keep dump bed clean
e. Keep moving parts properly greased
f. Distribute load properly
g. Cool off diesel engines by allowing engine to idle for a few minutes before shutdown

10. b, c, e, f, h, j, m, n, o

11. a. 3
b. 7
c. 6
d. 2
e. 1
f. 5
g. 4

ANSWERS TO TEST

12. a, b, c, d, e, h, j

13. Answer should include any ten of the following

    a. Use *all* safety features on truck, hoist, and bed

    b. Never stand or work under a raised, *loaded* bed

    c. Do not stand under a raised bed without first securely propping it

    d. Do not leave bed raised or partly raised while vehicle is unattended unless bed is securely propped

    e. When dumping, position truck on *solid, level* ground

    f. Always raise and lower bed slowly

    g. Always disengage PTO when hoist is not in use

    h. Report any malfunction of hoist or bed immediately

    i. Stay in cab during loading and dumping operations

    j. Be certain that all individuals are clear of hoist and bed before operating controls

    k. Use a spotter when available

    l. Be alert and watchful at all times

    m. Be ready to stop operation at any time if a hazardous condition occurs

    n. Look for hazards when traveling with the bed raised

    o. Do not ride or let any other person ride on *any* part of the vehicle other than in the cab

    p. Be especially cautious when roads are icy and visibility is low

    q. Know load capacities and do not exceed them

14. a. Feel

    b. Listen

    c. Smell

    d. Look

ANSWERS TO TEST

15. a, c, f

16. b, e, h, i, j, k, l

17. a, c, d, f, h, i, j, k

18. a. Answer should include any four of the following

    1. Material stuck together
    2. Material frozen in a mass
    3. Material frozen to bed
    4. Uneven loading
    5. Uneven dumping

    b. Answer should include any two of the following

    1. Uneven loading
    2. Excessive rear spring deflection
    3. Under-inflated tires

    c. Answer should include any two of the following

    1. Tailgating (operating with open tailgate)
    2. Traveling with a raised load
    3. High winds

19. a, d, e, f, h

20. Answer should include any seven of the following

    a. Do not exceed appropriate speeds for equipment and conditions

    b. Use all available safety warning devices

    c. Be alert for obstructions

    d. If truck skids, STEER INTO THE SKID until you regain some control, then steer back into the driving lane

ANSWERS TO TEST

- e. Plow in the direction of traffic
- f. Be wary of drivers coming from behind
- g. Wear protective clothing, especially gloves
- h. Know symptoms of cold exposure and frostbite
- i. Carry container of hot liquid (not alcohol)
- j. Carry emergency equipment

21. a, d, e, g, j, l, m, n, o

22. a. Plow from center line out to shoulders
    - b. "Cheat" across center line
    - c. Plow to low side of ramps or curves when possible
    - d. Plow away from wind whenever possible and practical
    - e. Raise blade before making a turn
    - f. Clear snow *past* intersection before making turnaround
    - g. Clear roadway before lifting blade; do not leave windrow of snow in traffic lane

23. a. Shallow
    - b. Acute

24. a. Hydraulic type
    - b. Fan type
    - c. Hopper type

25. a, c, d, f, g, i

26. a. Reverse procedures used to back a straight truck
    - b. Use a spotter
    - c. Back to the LEFT whenever possible
    - d. Avoid backing to the right except when absolutely necessary

ANSWERS TO TEST

27. Evaluated to the satisfaction of the instructor

28. Evaluated to the satisfaction of the instructor

29. Evaluated to the satisfaction of the instructor

30. Performance skills evaluated to the satisfaction of the instructor

TRACTORS
UNIT IX

UNIT OBJECTIVE

After completing this unit, the student should be able to operate tractors for highway maintenance work safely and effectively. This knowledge will be shown by completing the assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with tractor operation to their correct definitions.
2. Label parts of a tractor.
3. Identify controls on a typical tractor.
4. Match movement controls on a tractor to their correct functions.
5. Match implement controls on a tractor to their correct descriptions.
6. Match types of tractor transmissions to their correct descriptions.
7. Select from a list principles of brake operation.
8. State safety rules for operating tractors.
9. Select from a list procedures for effective tractor operation.
10. Select from a list procedures for operating a tractor on slopes or hills.
11. State safety rules for operating the hydraulic system.
12. State safety rules for power takeoffs.
13. Identify types of hitches.
14. Match adjustments to the drawbar to their correct descriptions.
15. Match parts of a three-point hitch to their correct functions.
16. Identify parts of a tractor tire.
17. Select from a list safety rules for changing a tractor tire.
18. Construct a list of general safety rules for the tractor operator.
19. Classify the parts of a three-point hitch.

OBJECTIVE SHEET

20. Demonstrate the ability to
    - a. Perform prestart inspection and maintenance procedures.
    - b. Service a tractor.
    - c. Start, warm up, and shut down a gasoline-powered tractor engine.
    - d. Start, warm up, and shut down a diesel-powered tractor engine.
    - e. Stop a tractor.
    - f. Operate a tractor.
    - g. Attach implement to a drawbar.
    - h. Attach implement to a three-point hitch.
    - i. Attach a power takeoff.
    - j. Operate a power takeoff.
    - k. Repair a tractor tire (cold patch).
    - l. Demount a tractor tire off the vehicle.
    - m. Mount a tractor tire off the vehicle.
    - n. Demount a tractor tire on the vehicle.
    - o. Mount a tractor tire on the vehicle.

TRACTORS
UNIT IX

SUGGESTED ACTIVITIES

I. Suggested activities

   A. Order materials to supplement unit.

      1. Teaching kits

         a. Instructor's kit--*Fundamentals of Machine Operation: Tractors.* Three-ring binder, 12 units, each with teaching guide, test and answers, laboratory exercises, study and discussion activities, transparency masters and script, and student text. FM0-107K kit. Slide set also available containing two hundred-twenty 35 mm color slides, FM0-102S Slides. Available from Deere and Company, Dept. S/P, 1400 Third Avenue, Moline, Illinois 61265.

         b. Tractor Safety Program Kit. Contains poster, safety brochures, course guide, and film and pamphlet resources 1969-70. Sponsored by Farm and Industrial Equipment Institute and National Safety Council--Farm Department. Available from your State Department of Vocational Agriculture.

      2. Leaflets

         a. *Prevent . . . Protect Against Tractor Upset* 699.31-143.

         b. *Program Guide for Tractor Safety* 699.31-120.

         (NOTE: Both leaflets are available from National Safety Council, 444 North Michigan Avenue, Chicago, Illinois 60611.)

      3. Films

         a. *Roll Guard.* Color, 16 mm, 10 minutes, Deere and Company, n.d. Available from Deere and Company, Moline, Illinois 61265

         (NOTE: This film discusses the rollover protective structure.)

         b. *Safe Operation of Farm Tractors.* Color, 16 mm, 14 minutes, Cornell University, 1973. Available from Cornell University Film Center, Ithaca, New York 14850.

         (NOTE: This film emphasizes the importance of a safe tractor for the operator. It presents a young man learning about daily maintenance, protective equipment, road and field hazards, hitches, PTO's, hydraulics, and the necessary skills to become a certified operator under the Occupational Safety and Health Act [OSHA].)

SUGGESTED ACTIVITIES

c. *Tractor Tragedies.* Color, 16 mm, 11 minutes, Wyoming University, n.d. Available from Wyoming University, Audiovisual Services, Box 3273 University Station, Laramie, Wyoming 82071. Phone (307) 766-3184.

(NOTE: This film shows actual scenes of tractors tipping and rolling. Each "accident" is analyzed as to whether it is caused by negligence, haste, or poor judgment.)

B. Make transparencies.

C. Provide students with objective sheet.

D. Provide students with information, assignment, and job sheets.

E. Discuss unit and specific objectives.

F. Discuss information and assignment sheets.

G. Demonstrate and discuss procedures outlined in job sheets.

H. Develop new jobs if job sheets in this unit are not practical.

I. Order operator manuals for equipment used in job sheets.

J. Invite resource person to talk on subjects such as

  1. Tractor safety.
  2. Operating a tractor for the maintenance department.
  3. Power takeoff and hydraulic systems.

K. Obtain large posters to illustrate parts and functions of a tractor.

L. Bring a tractor tire into class to demonstrate parts, safety techniques, and proper handling.

M. Make a three-point hitch available for students to study.

N. Arrange a field trip to a local tractor distributor.

O. Discuss the differences and similarities between agricultural and departmental maintenance tractor use.

P. Give test.

II. Instructional materials

A. Objective sheet

B. Suggested activities

C. Information sheet

SUGGESTED ACTIVITIES

D. Transparency masters

1. TM #1--Tractor Movement Controls
2. TM #2--Tractor Movement Controls (Continued)
3. TM #3--Tractor Implement Controls
4. TM #4--Three-point Hitch

E. Assignment sheets

1. Assignment Sheet #1--Construct a List of General Safety Rules for the Tractor Operator
2. Assignment Sheet #2--Classify the Parts of a Three-point Hitch

F. Answers to assignment sheets

G. Job sheets

1. Job Sheet #1--Perform Prestart Inspection and Maintenance Procedures
2. Job Sheet #2--Service a Tractor
3. Job Sheet #3--Start, Warm Up, and Shut Down a Gasoline-powered Tractor Engine
4. Job Sheet #4--Start, Warm Up, and Shut Down a Diesel-powered Tractor Engine
5. Job Sheet #5--Stop a Tractor
6. Job Sheet #6--Operate a Tractor
7. Job Sheet #7--Attach Implement to a Drawbar
8. Job Sheet #8--Attach Implement to a Three-point Hitch
9. Job Sheet #9--Attach a Power Takeoff
10. Job Sheet #10--Operate a Power Takeoff
11. Job Sheet #11--Repair a Tractor Tire (Cold Patch)
12. Job Sheet #12--Demount a Tractor Tire Off the Vehicle
13. Job Sheet #13--Mount a Tractor Tire Off the Vehicle
14. Job Sheet #14--Demount a Tractor Tire on the Vehicle
15. Job Sheet #15--Mount a Tractor Tire on the Vehicle

SUGGESTED ACTIVITIES

H. Test

I. Answers to test

III. Unit references

A. *Fundamentals of Machine Operation: Tractors.* Moline, Illinois: Deere & Company, 1981.

B. *Fundamentals of Service: Tires and Tracks.* Moline, Illinois: Deere & Company, 1970.

C. *Operator's Manual: 2630 Tractor.* Moline, Illinois: Deere & Company, n.d.

D. *Safe Tractor Operation and Daily Care*, rev. ed. Athens, Georgia: American Association for Vocational Instructional Materials, 1981.

TRACTORS
UNIT IX

INFORMATION SHEET

I. Terms and definitions

A. Spline--Parallel groove running lengthwise on a shaft

B. Retard--To slow down

C. Rockshaft system--Controls for equipment mounted on a three-point hitch

D. Draft--Load-pulling capacity

E. Seat--To cause two surfaces to fit firmly together

F. Power takeoff (PTO)--Mechanical connection on an engine or transmission to which a cable, belt, or shaft can be connected to drive an attachment or tool

G. Bead--Part of tire that fits against rim

H. Hydrostatic--Equipped with hydraulically powered controls

I. Implement--Tool attached to tractor to do a specific job

EXAMPLES: Mower, posthole digger, sweeper, roller

J. Road--To travel equipment under its own power

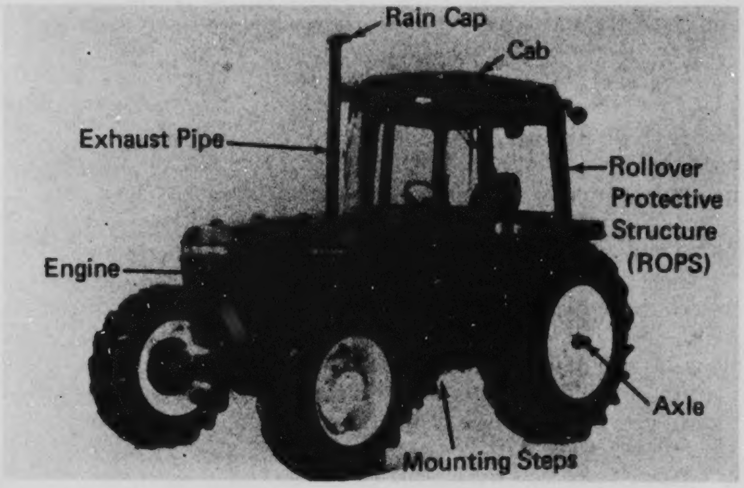
K. Transport--To travel equipment by loading it on another vehicle

L. Turbocharger--Exhaust-driven centrifugal air compressor; used to increase power

INFORMATION SHEET

II. Parts of a tractor (Figure 1; Job Sheet #2)

FIGURE 1

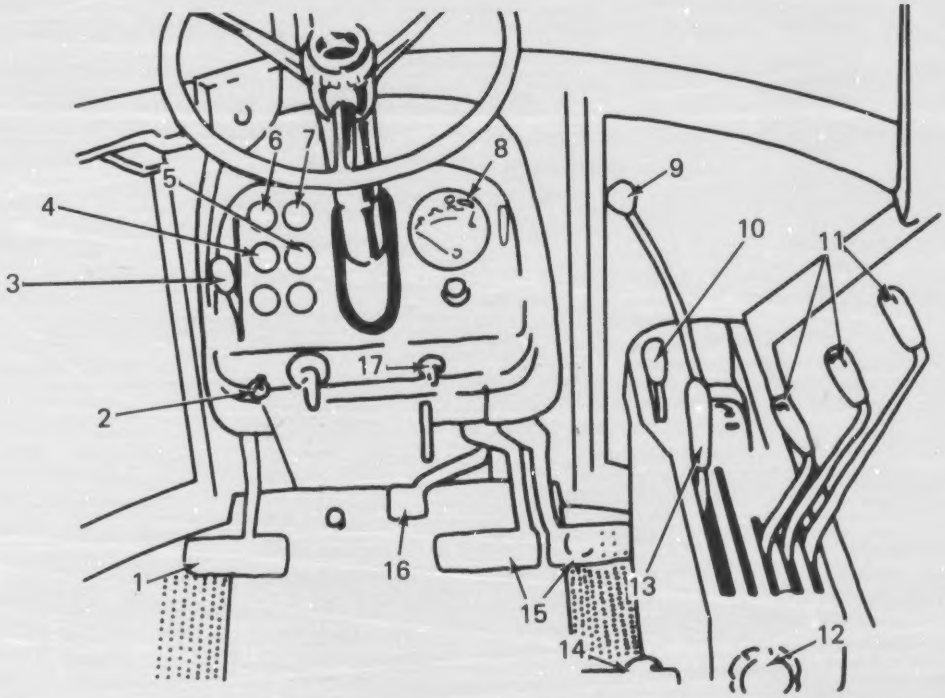

Rain Cap
Cab
Exhaust Pipe
Rollover Protective Structure (ROPS)
Engine
Axle
Mounting Steps

Used with permission of Deere & Company, Moline, Illinois.

INFORMATION SHEET

III. Controls on a typical tractor (Figure 2; Transparencies #1 and #2; Job Sheets #3-#6)

FIGURE 2



1. Clutch or inching pedal
2. Fuel shutoff valve (diesel)
3. Power takeoff clutch lever
4. Engine oil pressure gauge
5. Ammeter
6. Fuel gauge
7. Engine temperature gauge
8. Speed/hourmeter (rpm and hours of operation)
9. Shift lever
10. Hand throttle
11. Remote hydraulic operating levers
12. Rockshaft stop-adjusting knob
13. Rockshaft control lever
14. Rockshaft selector lever
15. Brake pedals
16. Differential lock pedal
17. Ignition key and starter switch

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INFORMATION SHEET

IV. Functions of movement controls on a tractor (Transparencies #1 and #2; Job Sheets #3 and #4)

A. Brake pedals--Stop tractor and assist in turning

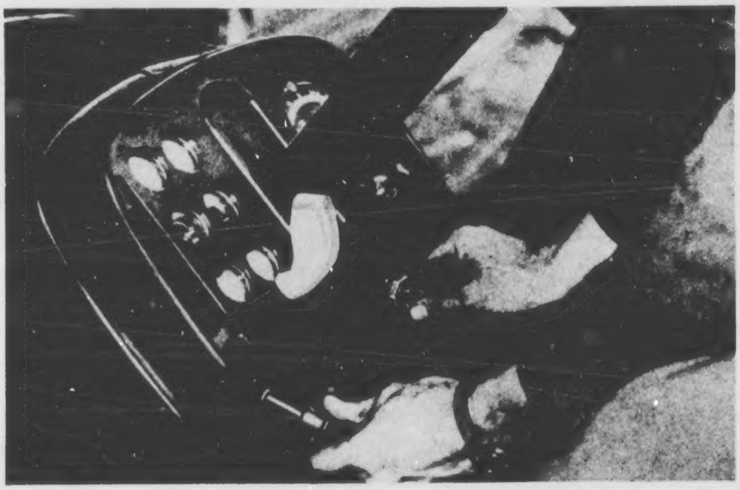
(NOTE: Brake locks slide across to position for using both brakes.)

B. Differential lock pedal--Turns both rear wheels at same speed

C. Hand and foot throttles--Regulate flow of fuel to engine

D. Fuel shutoff valve (diesel engines only)--Stops flow of fuel to injection pump (Figure 3)

FIGURE 3



Courtesy of Deere & Company, Moline, Illinois.

INFORMATION SHEET

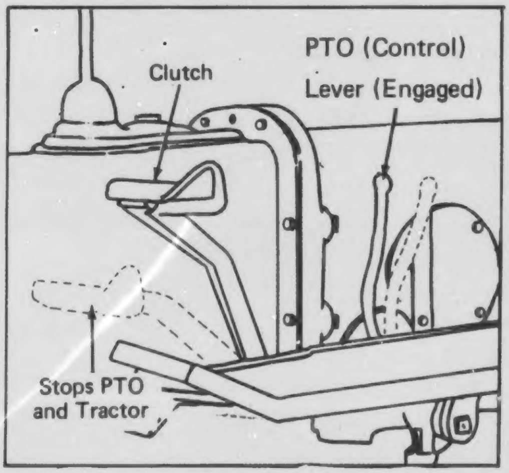
V. Implement controls on a tractor (Figures 4-11; Transparency #3)

A. PTO engagement control

(NOTE: Tractors may be equipped with one or more types of power takeoff drives: transmission-driven, independent-running, or continuous-running. Some tractors will have auxiliary PTOs.)

1. Transmission-driven PTO--Clutch engages or disengages power shaft and transmission shaft at same time; operates only when clutch is engaged

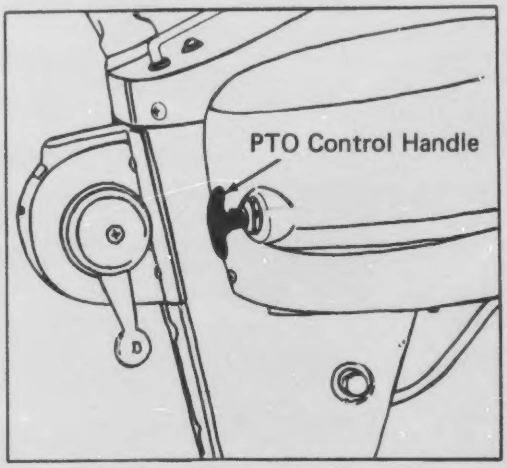
FIGURE 4



Used with permission of the American Association for Vocational Instructional Materials, Athens, Georgia.

2. Independent PTO--Controlled by a separate drive; will operate with tractor in motion, at a standstill, starting, or stopping

FIGURE 5



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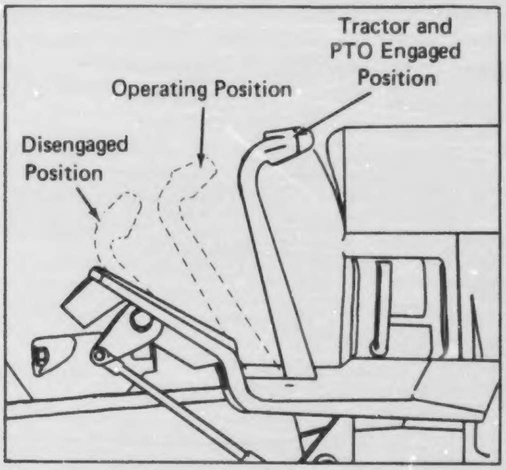
INFORMATION SHEET

3. Continuous-running PTO--Controlled by double-acting clutch

   (NOTE: With clutch half depressed or completely depressed, both shafts are disconnected. With clutch completely released, power is supplied to both shafts.)

FIGURE 6


Tractor and PTO Engaged Position
Operating Position
Disengaged Position

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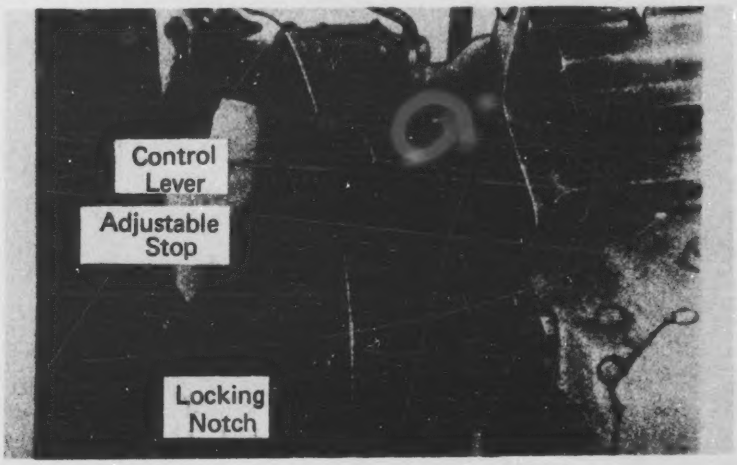
B. Rockshaft control lever--Raises and lowers the hydraulic draft links on a three-point hitch

   (NOTE: The rockshaft system consists of the rockshaft control lever, the rockshaft speed control, and rockshaft selector controls. These are located to the right of the operator's seat.)

FIGURE 7


Control Lever
Adjustable Stop
Locking Notch

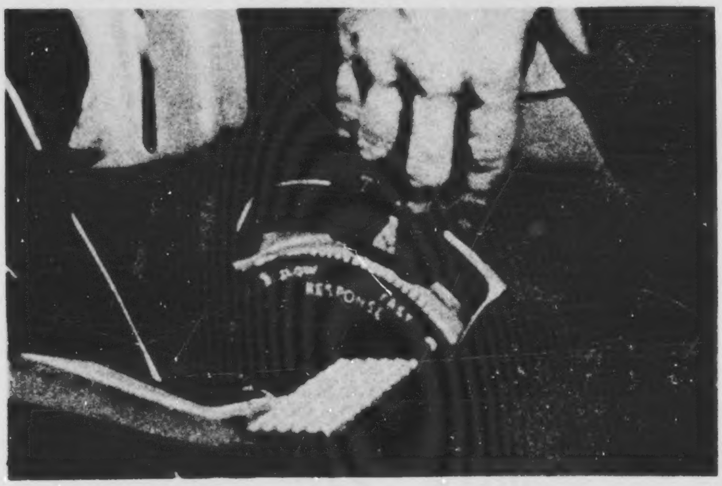
Courtesy of Deere & Company, Moline, Illinois.

INFORMATION SHEET

C. Rockshaft speed control--Regulates speed at which implement is raised or lowered

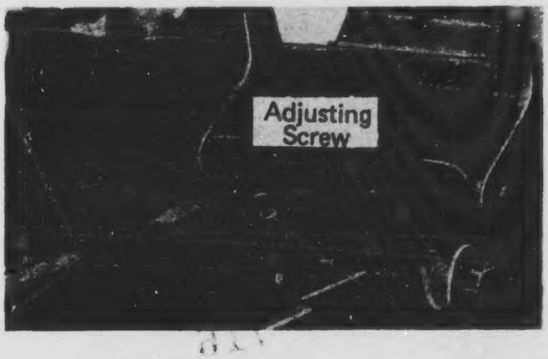
(NOTE: On some models, an adjusting screw is used to preset the rate of implement drop.)

FIGURE 8


SLOW
RESPONSE
FAST

Courtesy of Deere & Company, Moline, Illinois.

FIGURE 9

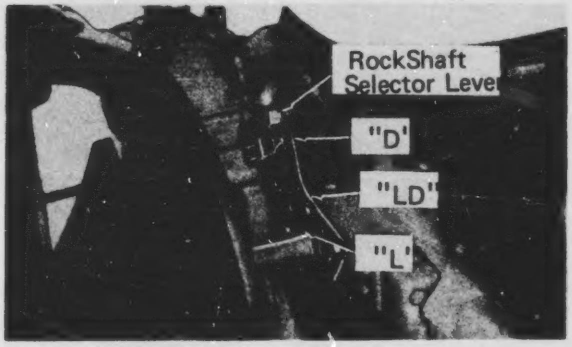

Adjusting Screw

Courtesy of Deere & Company, Moline, Illinois.

INFORMATION SHEET

D. Rockshaft selector lever--Sets load and depth sensitivity

FIGURE 10



Courtesy of Deere & Company, Moline, Illinois.

(NOTE: Selector lever controls function as follows: "L" or Load Control--The rockshaft automatically raises and lowers the hitch and implements to maintain a constant load through variations in soil density or ground contour.

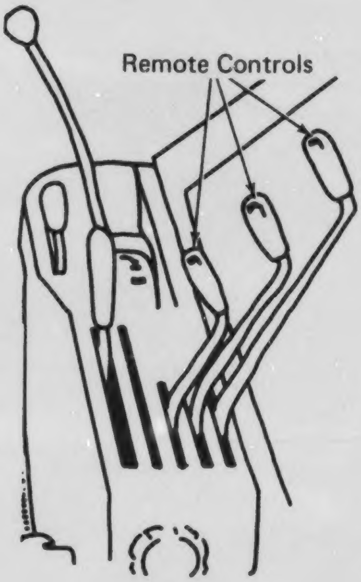
"D" or Depth Control--The implement attached to the three-point hitch will work at the depth selected by the rockshaft control lever, regardless of the amount of pull required.

"LD" or Load and Depth Control--The rockshaft will maintain a nearly uniform implement working depth, but will also allow the hitch and implement to rise or sink slightly, as soil conditions vary.)

INFORMATION SHEET

E. Remote controls--Regulate remote hydraulic cylinders for raising or lowering towed implements

FIGURE 11



Used with permission of Deere & Company, Moline, Illinois.

VI. Types of tractor transmissions

A. Manual--Operating gear is selected, and clutch is engaged to shift; must stop tractor to shift gears

B. Synchronized--Clutch is engaged to shift gears while in motion

C. Power-assisted or hydraulically engaged--Has no clutch; uses an inching pedal for shifting, operating implements, and hard pulls

D. High-low shift--Can change gear ranges while tractor is in motion

(NOTE: In situations in which a truck uses LOW range for engine braking, a tractor uses HIGH.)

EXAMPLE: Going down steep hills

(CAUTION: If the tractor is not equipped with a high-low shift, operator must stop the tractor to change the gear range.)

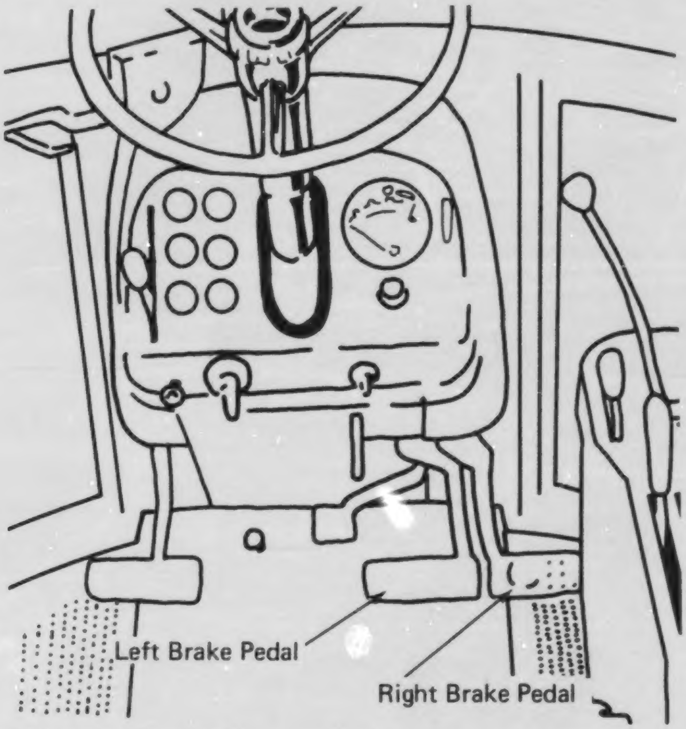
INFORMATION SHEET

VII. Principles of brake operation (Figures 12-14)

A. A left brake pedal and a right brake pedal control brakes to left wheel and right wheel

(NOTE: Both pedals are located on the right side of the tractor.)

FIGURE 12


Left Brake Pedal
Right Brake Pedal

Courtesy of Deere & Company, Moline, Illinois.

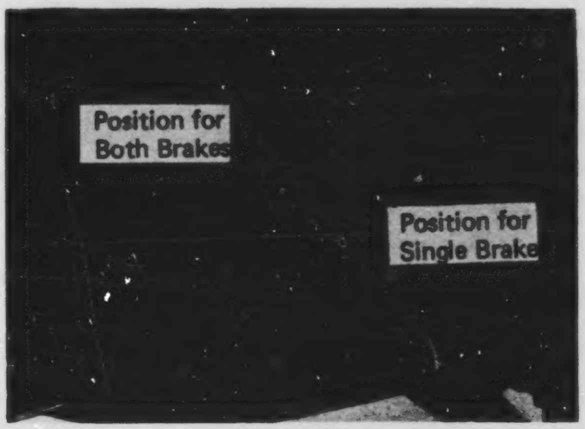
INFORMATION SHEET

B. Brakes operate independently, or they can be locked together

(NOTE: The type of locking device will vary.)

EXAMPLE:

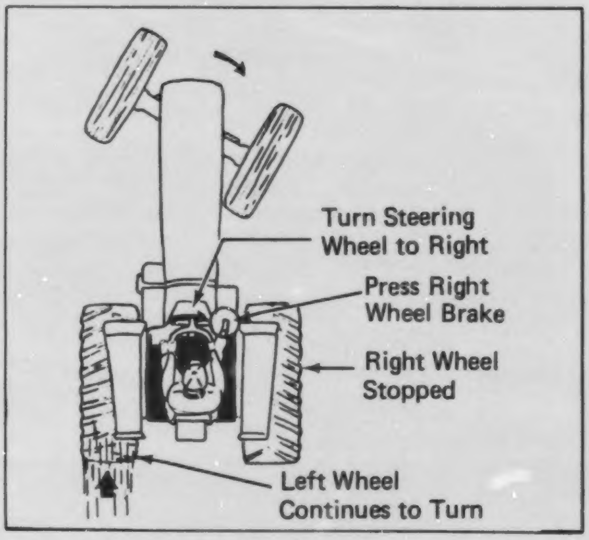
FIGURE 13


Position for Both Brakes
Position for Single Brake

Courtesy of Deere & Company, Moline, Illinois.

C. Brakes operated independently assist in making short turns

FIGURE 14


Turn Steering Wheel to Right
Press Right Wheel Brake
Right Wheel Stopped
Left Wheel Continues to Turn

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INFORMATION SHEET

D. Locked brakes are used for emergency stops and for parking the tractor

E. Brakes *must* be locked when traveling on roads or highways

(NOTE: If you hit only one brake at highway speed [20-25 mph], the tractor may tip over.)

F. Brakes must be adjusted evenly and checked regularly

G. Brakes should always be applied *gradually*

VIII. Safety rules for operating tractors (Assignment Sheet #1)

(NOTE: Think about safety *before* accidents occur.)

A. Read the operator's manual thoroughly and know the machine

B. Study departmental safety manual

C. Wear close-fitting clothing

D. Wear ear protection if needed

E. Provide for ventilation

F. Become familiar with controls

(NOTE: Be sure you know how to stop the tractor and engine.)

G. Do not let another person on or near the tractor when it is in operation

(NOTE: With mower attached, shut down mower if a person or animal approaches.)

H. Remove or tie down loose tools and equipment

I. Keep seat belt fastened

(NOTE: Wear seat belt only if tractor is equipped with a ROPS.)

J. Stay seated during operation

K. Use all lights and safety warning devices

L. Check brakes

M. Disengage PTO when not operating attachment

N. Do not smoke while working on tractor

(NOTE: Hydrogen gas builds up and will ignite.)

EXAMPLES: While filling fuel tank, while checking or filling batteries, while handling fuels or solvents

INFORMATION SHEET

IX. Procedures for effective tractor operation (Job Sheets #1 and #6)

A. Perform prestart inspection and maintenance procedures

B. Keep speed down

C. Avoid sudden starts, stops, and turns

D. SLOW DOWN before a turn

(NOTE: A tractor will tip over at approximately 8 mph when turning on level ground.)

E. Take care when entering highway

F. Adjust speed for highway travel

(NOTE: Consider the condition of the road, the tractor, the traffic, and the weather. As speed doubles, the chances of the tractor's tipping over become four times as great. Always use extreme caution.)

G. Signal all turns and stops

H. Travel completely on the shoulder when possible

(CAUTION: Avoid driving half on the road and half on the shoulder.)

I. Stay clear of ditches, embankments, and excavations

J. Do not touch electrical wires with any part of the tractor

K. Follow departmental preventive maintenance program

L. When transporting tractor, cover rain cap to protect turbocharger

(NOTE: If rain cap is uncovered, wind will turn blades and overheat turbocharger unit.)

X. Procedures for operating a tractor on slopes or hills

A. Reduce speed

B. Do not drive up hills if you can avoid them

(NOTE: Backward upsets can happen in 1/2 to 1 1/3 seconds.)

C. Engage clutch *slowly* when driving out of a ditch, gully, or up a steep slope

(NOTE: Be prepared to disengage the clutch immediately if the front wheels rise off the ground.)

INFORMATION SHEET

D. Go up steep slopes in reverse

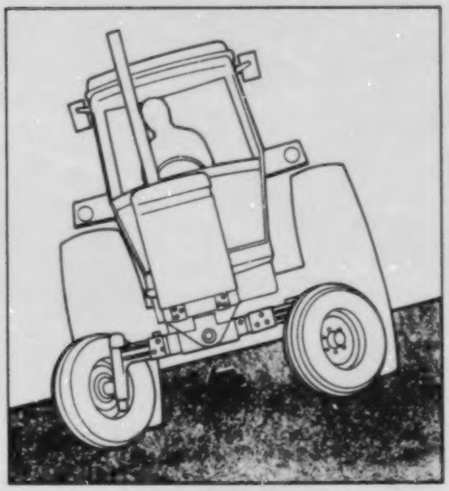
E. Do not go downhill with heavy loads

F. Keep tractor in gear when going downhill

G. Turn steering DOWNHILL if tractor starts to tilt while on a slope (Figure 15)

(NOTE: The natural tendency is to steer uphill, but this will increase the chances of overturning.)

FIGURE 15



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XI. Safety rules for operating the hydraulic system (Assignment Sheet #1)

(CAUTION: Hydraulic fluid escaping under pressure can be extremely dangerous. Serious injury may result from hydraulic fluid piercing skin and tissue.)

A. Use caution when working with hydraulic system

B. Wear gloves; use a blocking material such as cardboard or rags when checking hydraulic lines for leaks

C. Stand clear when working with hydraulic lines and tools

D. Keep hydraulic system clean

(NOTE: Always use dust caps on quick-couple disconnect when hydraulic system is not in use.)

INFORMATION SHEET

E. Use proper fittings for hoses and attachments

F. Never depend on the hydraulic system to support machine parts

EXAMPLE: Block or jack up rotary motor wings; if they are raised to a vertical position, secure them with chains or fastening rods.

G. Release pressure from hydraulic system when machine is shut down by moving all levers and steering wheel

H. Avoid prolonged contact with hydraulic fluid

(NOTE: Hydraulic fluid is a skin irritant.)

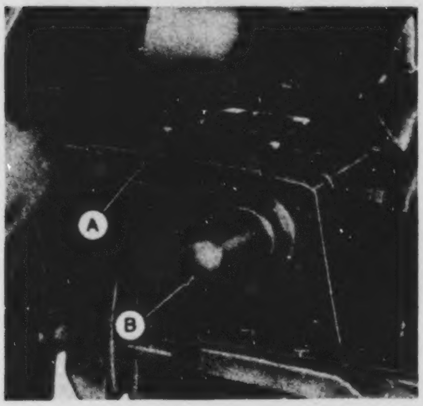
INFORMATION SHEET

XII. Safety rules for power takeoffs (Assignment Sheet #1; Job Sheets #9 and #10)

(NOTE: Tractors have either 540 rpm PTO shafts, 1000 rpm PTO shafts, or both. A 540 rpm implement cannot be connected to 1000 rpm PTO stub shaft or vice versa. Some tractors have interchangeable stub shafts and are equipped with a selector lever to provide the different speeds. With a lever always be sure selector is set for appropriate rpms, or engine damage and serious injury can occur.)

A. Keep PTO guards and shields in place, even when PTO is not running (Figures 16 and 17)

FIGURE 16 PTO Guards

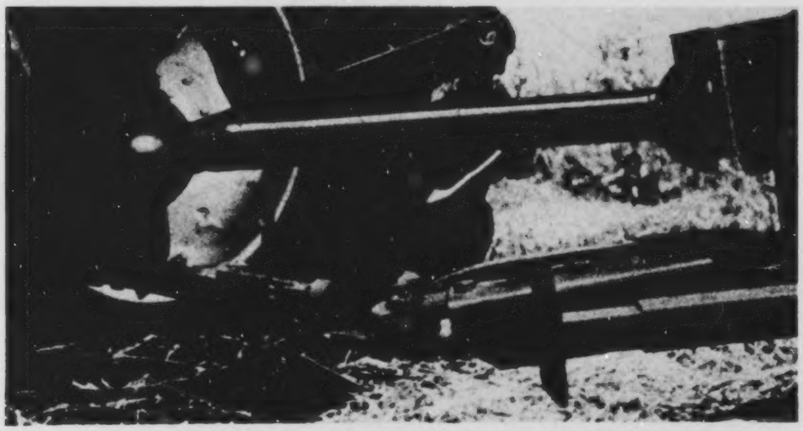


A. Master Shield

B. PTO Shaft Guard

Courtesy of Deere & Company, Moline, Illinois.

FIGURE 17 Powershaft Guard



Courtesy of Deere & Company, Moline, Illinois.

INFORMATION SHEET

B. Always disconnect PTO when not in use

(NOTE: Failure to disconnect the PTO when not in use accounts for many operator injuries.)

C. Never engage PTO while machine engine is shut off

D. Keep hands, feet, and clothing away from PTO parts

E. Be sure clothing fits snugly

F. Never operate PTO shafts at extreme angles

G. Never ride, or let others ride, on drawbar of tractor

H. Be sure PTO spinner shields rotate freely at all times

(NOTE: Disengage all power and shut off tractor engine before checking spinner shields.)

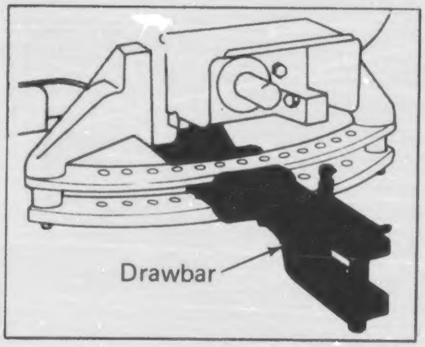
I. Always be sure PTO stub shaft is properly secured to machine's powershaft

J. Do not service, lubricate, or perform other work without first disengaging PTO and shutting off tractor engine

XIII. Types of hitches (Figures 18-21; Job Sheets #7 and #8)

A. Drawbar

FIGURE 18



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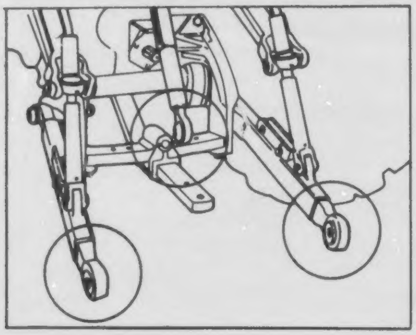
INFORMATION SHEET

B. Three-point hitch

FIGURE 19



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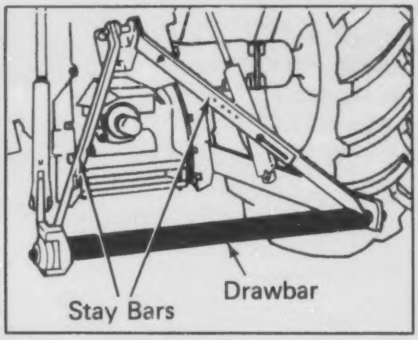
C. Drawbar as three-point hitch

FIGURE 20



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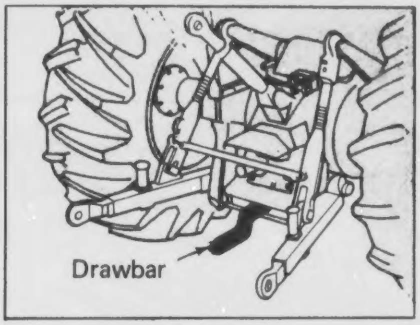
D. Drawbar and three-point hitch

FIGURE 21



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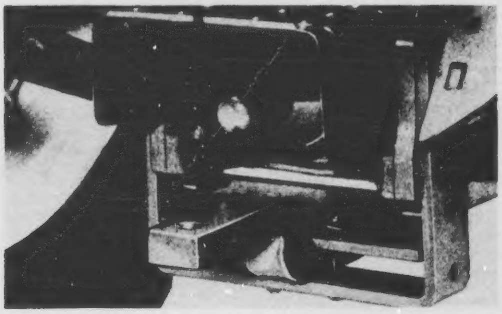
INFORMATION SHEET

XIV. Adjustments to the drawbar (Figures 22-29; Job Sheet #7)

A. Length--Short position or extended position

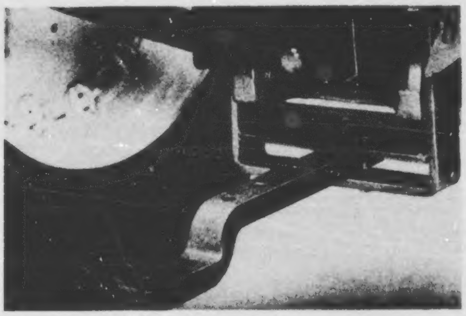
(NOTE: Use extended position for any operations using PTO equipment.)

FIGURE 22 Short Position



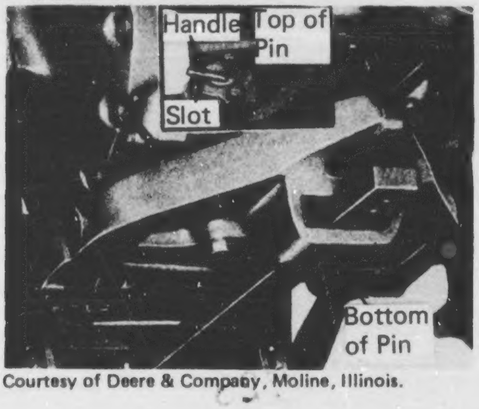
Courtesy of Deere & Company, Moline, Illinois.

FIGURE 23 Extended Position



Courtesy of Deere & Company, Moline, Illinois.

FIGURE 24 Adjust Underneath Tractor Body



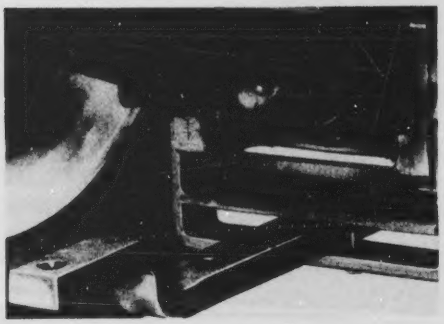
Courtesy of Deere & Company, Moline, Illinois.

INFORMATION SHEET

B. Drawbar height--Leave 13 to 20 inches ground clearance, measured from top of drawbar

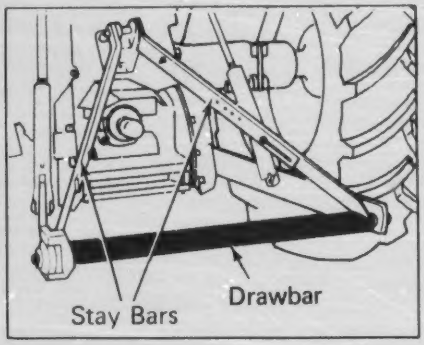
(NOTE: Height can be adjusted by inverting the drawbar [Figure 25]. If the tractor is equipped with a drawbar mounted as part of the three-point hitch, stay bars should be installed to hold the drawbar at the correct height [Figure 26].)

FIGURE 25



Courtesy of Deere & Company, Moline, Illinois.

FIGURE 26



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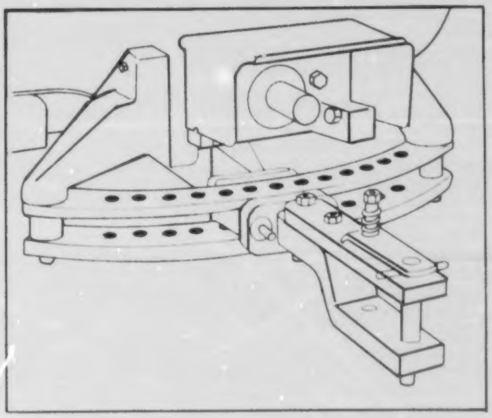
C. Lateral adjustment--Swinging position for operation; fixed position for transporting

FIGURE 27



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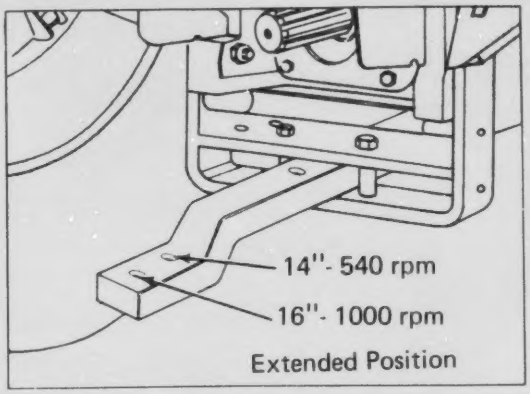
INFORMATION SHEET

D. PTO speed shaft--Fourteen inches for 540 rpm, 16 inches for 1000 rpm

(NOTE: On some models, length adjustment is made under tractor body.)

(CAUTION: Maintain proper drawbar height and length to prevent tractor from upsetting and to protect PTO shaft.)

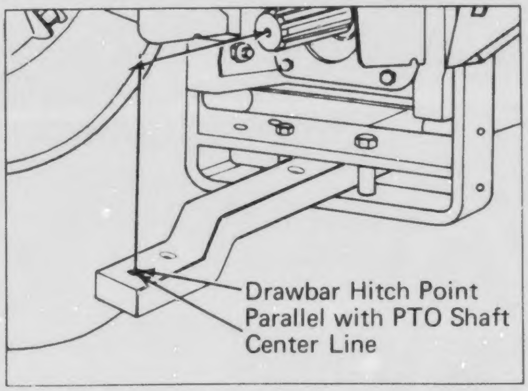
FIGURE 28



Used with permission of the American Association for Vocational Instructional Materials, Athens, Georgia.

E. PTO alignment--Drawbar hitch point parallel with PTO shaft center line

FIGURE 29



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XV. Parts of a three-point hitch (Transparency #4; Assignment Sheet #2; Job Sheet #8)

A. Rockshaft lift arms--Raise or lower implement during operation

B. Lift link adjusting handle--Raises or lowers right lift link level with left lift link for attaching implement

C. Sway blocks--Permit implement to swing freely during operation

D. Lift links--Adjust height of hitch to implement

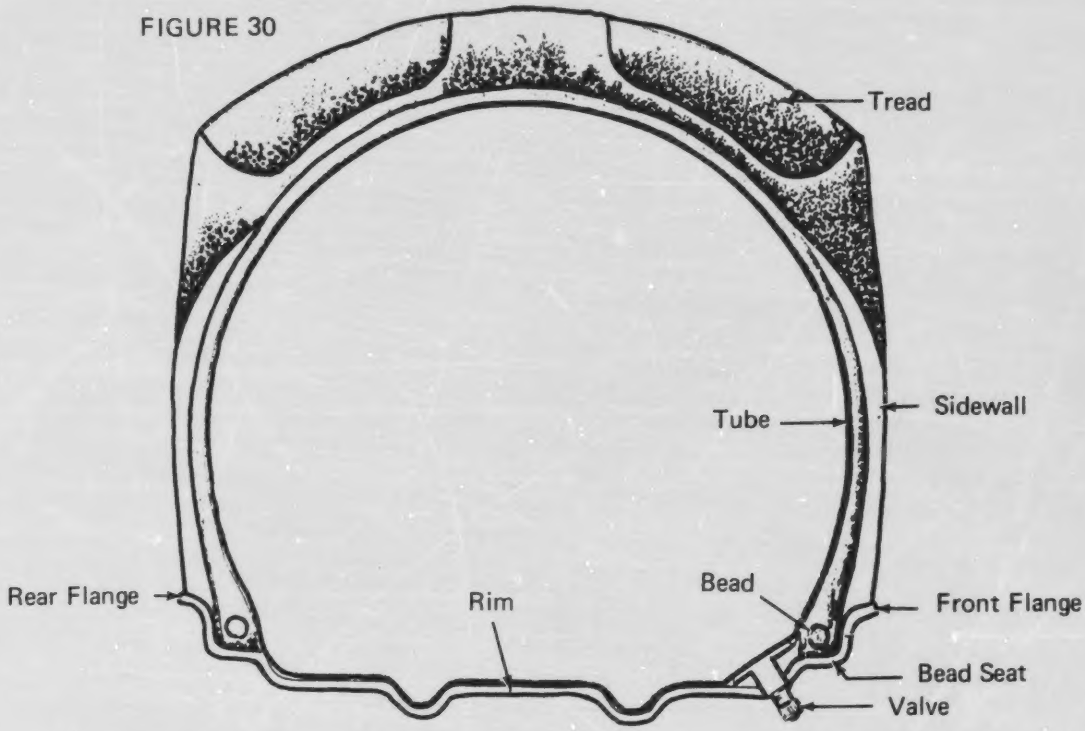
E. Lower links or draft links--Attach to implement; provide pull

F. Center link--Attaches to implement

G. Center link adjusting handle--Adjusts length of center link to fit implement

XVI. Parts of a tractor tire (Figure 30)

FIGURE 30



Used with permission of Goodyear Tire and Rubber Company, Akron, Ohio.

XVII. Safety rules for changing a tractor tire (Assignment Sheet #1; Job Sheets #11-15)

(CAUTION: An inflated tire and the rim on which it is mounted can be very dangerous. Under pressure the tire packs the explosive force of TNT.)

A. Follow recommended procedures

B. Use only proper equipment and tools

C. NEVER attempt to unseat beads of an inflated tire

D. Exhaust ALL air from tire

INFORMATION SHEET

E. Keep a "safe body" attitude

EXAMPLES:
1. Keep fingers clear when working hydraulic bead breakers.
2. Stand clear when appling hydraulic pressure.
3. Stand to the side while inflating tire.
4. Stand clear when using a cable or chain sling.

F. Inspect and clean all surfaces

EXAMPLES: Rim, inside of tire, new tube

Tractor Movement Controls

- **Clutch Pedal**
- **Gearshift Levers**
- **Brake Pedals**
- **Differential Lock Pedal**

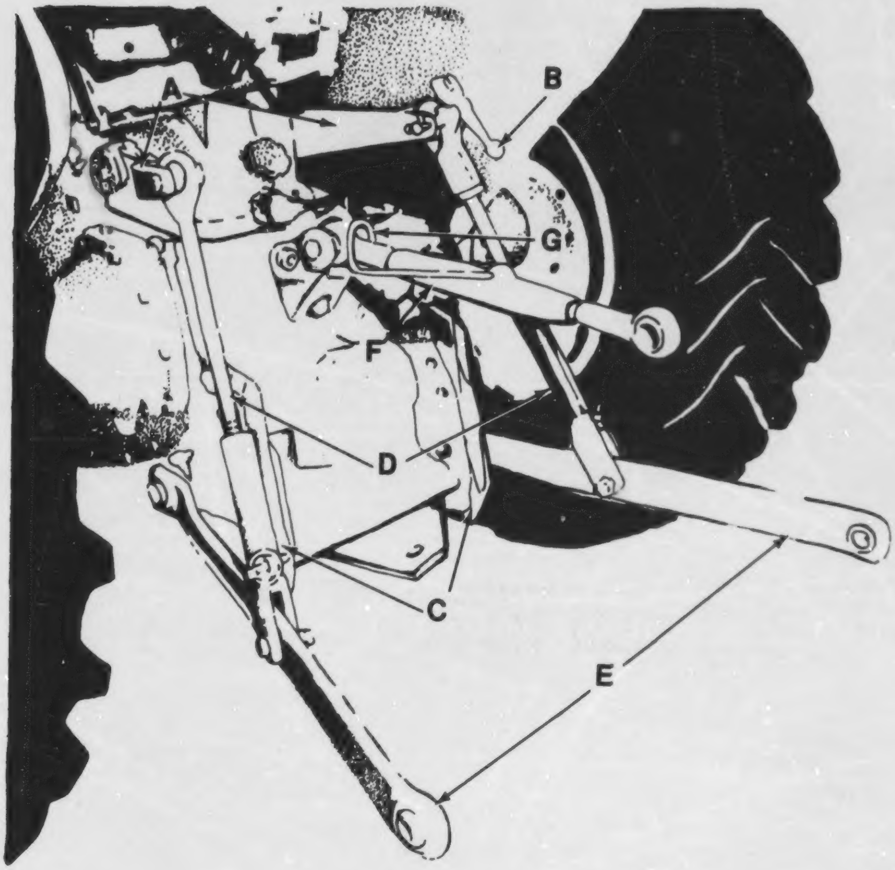
Tractor Movement Controls
(Continued)

- Hand and Foot Throttles
- Ignition Switches and Electrical Master Switches
- Fuel Shutoff Valve (Diesel Engines Only)
- Choke (Gasoline Engines)

Tractor Implement Controls

- **Rockshaft System Levers**
  1. Control Lever
  2. Speed Control
  3. Selector Controls
- **Remote-Control Levers**
- **PTO-Engagement Control**

Three-Point Hitch



A. Rockshaft Lift Arms

B. Lift Link Adjusting Handle

C. Sway Blocks

D. Lift Links

E. Draft Links or Lower Links

F. Center Link

G. Center Link Adjusting Handle

Adapted with permission of Deere & Co., Moline, Illinois

TRACTORS
UNIT IX

ASSIGNMENT SHEET #1--CONSTRUCT A LIST OF GENERAL SAFETY RULES FOR THE TRACTOR OPERATOR

NAME ______________________________ SCORE ____________

Safety is the first concern of every operator. He or she should develop a "safety sense" for working with equipment.

This assignment sheet will help you focus on specific safety procedures and attitudes for working with tractors. Review the safety rules for operating tractors, hydraulic systems, power takeoffs, and for changing a tire. Then answer the following questions and construct your own list of general safety rules for operating tractors.

A. Which rules do these operations have in common?

____

____

____

____

____

B. For each operation, which three rules, *specific to that operation*, do you consider the most important?

1. Tractor operation
   a) ______________________________
   b) ______________________________
   c) ______________________________
2. Hydraulic system
   a) ______________________________
   b) ______________________________
   c) ______________________________
3. Power takeoff
   a) ______________________________
   b) ______________________________
   c) ______________________________

ASSIGNMENT SHEET #1

4. Changing a tire

a) ____________________

b) ____________________

c) ____________________

C. Overall, what factors in this unit seem to present the greatest danger to the operator?

D. Construct a list of general rules for operating tractors.

1. Clothes-- ____________________

2. Personal safety-- ____________________

3. Safety of others-- ____________________

ASSIGNMENT SHEET #1

4. Equipment-- ____

____

____

____

____

TRACTORS
UNIT IX

ASSIGNMENT SHEET #2--CLASSIFY THE PARTS OF A THREE-POINT HITCH

NAME ______________________________ SCORE ______________

The three-point hitch provides a fast, easy method of attaching rear-mounted equipment--mowers, rollers, and augers. It is essential that the operator be thoroughly familiar with the parts of the hitch and how they operate.

Classify the parts of a three-point hitch according to the following categories. Write the names of the parts and their functions in the blanks.

A. Parts that lift--______________________________

____

____

____

____

____

B. Parts that attach the implement to the tractor--______________________________

____

____

____

____

____

C. Parts that allow sideways movement--______________________________

____

____

____

____

____

TRACTORS
UNIT IX

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

(NOTE: These are suggested answers.)

A. Answers should fall into three general categories--Keep the body clear, wear proper (close-fitting) clothing, and know your equipment

B. Evaluated to the satisfaction of the instructor

C. Answers may include--Moving parts, failure to pay attention to proper procedures, danger inherent in working with tractors and equipment

D. Answer should include the following

  1. Wear close-fitting clothing, hard hat, gloves, safety goggles, ear protection

  2. Keep the body clear of moving and pressurized parts, wearing protective clothing, keep alert

  3. Keep people away from equipment, check the work area, use safety and warning devices

  4. Read manuals, know procedures, keep guards and shields in place, use proper tools and parts, know the equipment

Assignment Sheet #2

A. 1. Rockshaft lift arms--Raise or lower implement during operation

  2. Lift link adjusting handle--Raises or lowers right lift link level with left lift link for attaching implement

  3. Lift links--Adjust height of hitch to implement

B. 1. Lower links or draft links--Provide pull

  2. Center link--Secures implement to tractor

  3. Center link adjusting handle--Adjusts length of center link to fit implement

C. Sway blocks--Permit implement to sway freely during operation

TRACTORS
UNIT IX

JOB SHEET #1--PERFORM PRESTART INSPECTION AND MAINTENANCE PROCEDURES

I. Equipment and materials

A. Tractor

B. Operator's manual

C. Engine oil

D. Engine coolant

E. Hydraulic fluid

F. Fuel

G. Lubricants

H. Grease gun

I. Rags

II. Procedure

(NOTE: Deficiencies should be corrected immediately or reported to the proper authority. Do not operate defective equipment.)

A. Make a walk-around visual inspection for broken, worn, or missing parts, and leaks

B. Check engine oil level; add or change oil if needed

C. Check engine coolant level; add coolant if needed

D. Check hydraulic reservoir level; add fluid if needed

E. Check fuel level; fill tank if needed

F. Check battery connections for tightness and corrosion

G. Check battery electrolyte level; add water if needed

H. Check air cleaner; remove and clean filter if needed

I. Check brakes

J. Check tires

K. Clean all grease fittings and lubricate according to instructions in operator's manual

L. Check hydraulic system for leaking lines and connections, bent or kinked lines, and lines rubbing against other parts

JOB SHEET #1

M. Check drive belts for tightness

N. Check electrical wire connections and insulation

O. Clean windshield and mirrors; adjust mirrors

P. Check gauges

Q. Check foot pedals for proper functioning

R. Check levers and controls for proper functioning

S. Remove trash

T. Check lights

U. Check safety devices

V. Clean grills

W. Check hitch for proper alignment; adjust if necessary

TRACTORS
UNIT IX

JOB SHEET #2--SERVICE A TRACTOR

I. Equipment and materials

A. Tractor

B. Operator's manual

C. Tool kit

D. Air supply

E. Grease gun

F. Lubricants

G. Cleaning solvents

H. Rags

I. Water

J. Engine coolant

K. Engine oil

L. Hydraulic fluid

M. Transmission fluid

N. Brake fluid

O. Tire pressure gauge

P. Fuel

II. Procedure

(NOTE: Follow departmental preventive maintenance program when servicing equipment. Refer to operator's manual for lubrication chart and service for specific components and attachments.)

A. Visually inspect for leaks and broken, worn, or missing parts

(NOTE: Major repairs and replacements should be reported to the proper authority and completed by a trained mechanic.)

B. Check engine oil level, filter, and lines and hoses; add or change engine oil if necessary

JOB SHEET #2

C. Check engine coolant level, radiator cap, hose, and radiator; add coolant if needed

(CAUTION: Do not remove radiator cap unless engine is cool; open cap slowly to release pressure.)

D. Clean air filter; replace as needed

E. Check fuel level, fuel filters, and sediment bowl (where applicable); fill fuel tank

F. Check battery electrolyte level, battery cables, and connectors; add water or electrolyte if needed

(NOTE: Keep sparks and fire away from battery.)

G. Check exhaust system for loose connections and holes

H. Check hydraulic fluid level, filters, hose, lines, and fittings and look for leaks; add fluid if needed

I. Check transmission fluid level; add fluid if needed

J. Check transmission pressure line filter and breather

K. Check brake adjustment and condition; adjust if necessary

L. Check brake master cylinder fluid level; fill if needed

M. Check clutch adjustment; adjust if necessary

N. Check drive belts for tension and wear; adjust or replace if necessary

O. Check wiring, insulation, and connections

P. Clean and lubricate grease fittings according to operator's manual

Q. Check tire pressure, inflate to recommended pressure

R. Check condition of tires

S. Check all safety devices; repair if necessary

T. Check major components and/or accessories

U. Check hitch for wear and adjustments

TRACTORS
UNIT IX

JOB SHEET #3--START, WARM UP, AND SHUT DOWN A GASOLINE-POWERED TRACTOR ENGINE

I. Equipment

  A. Gasoline-powered tractor

  B. Operator's manual

II. Procedure

  A. Read operator's manual for procedures and controls

  B. Perform inspection, daily maintenance, and safety checks

  C. Mount tractor properly

  D. Adjust seat; fasten seat belt if tractor is equipped with ROPS (rollover protective structure)

  (NOTE: Never operate tractor or start engine from any place except tractor seat.)

  E. Check to see that gearshift is in PARK or NEUTRAL; lock the brakes

  F. Check to see that PTO lever and all other systems controls are in the OFF or NEUTRAL positions

  G. Turn key or ignition switch to ON position

  H. Open throttle to one-third or one-half position

  (NOTE: In cold weather, use cold weather starting aids. See operator's manual.)

  I. Check all warning lights

  J. Check fuel gauge

  K. Pull out choke

  L. Depress clutch

  M. Crank engine

  (NOTE: Crank device may be a button, lever, combination ignition and starting key, or gear lever position. See operator's manual.)

  (CAUTION: Do not crank engine for more than twenty seconds. Allow engine to cool for at least two minutes before attempting to start the tractor again.)

JOB SHEET #3

N. Release starter switch as soon as engine starts

O. Release clutch SLOWLY

P. Check oil pressure gauges

Q. Adjust choke as engine warms up to keep tractor running smoothly

(NOTE: Push choke in slowly. If you pull it out too far or push it in too quickly, the engine will miss.)

R. Check ammeter to see that battery is charging

S. Adjust choke to higher idling speed after two minutes

T. Watch engine coolant temperature gauge to determine when engine is warmed

U. To shut down, allow engine to idle for two to three minutes

(NOTE: This permits the engine to cool down and allows for gradual and uniform cooling of engine parts. It also prevents damage to the turbocharger by allowing it to slow down.)

V. Place gearshift lever in PARK or NEUTRAL and lock brakes

W. Lower equipment

X. Disengage all other drives

Y. Turn off all electrical switches except ignition

Z. Retard throttle

AA. Turn off ignition switch

BB. Set brakes

CC. Remove key

DD. Dismount properly

(CAUTION: Wait for all moving parts to stop before dismounting.)

TRACTORS
UNIT IX

JOB SHEET #4--START, WARM UP, AND SHUT DOWN A DIESEL-POWERED TRACTOR ENGINE

I. Equipment and materials

A. Diesel-powered tractor

B. Operator's manual

II. Procedure

A. Read the operator's manual for procedures and controls for your tractor

B. Perform inspection, daily maintenance, and safety checks

C. Mount tractor properly

D. Adjust seat; fasten seat belt if tractor is equipped with ROPS (rollover protective structure)

(NOTE: Never operate the tractor or start the engine from any place except the tractor seat.)

E. Check to see that gearshift is in PARK or NEUTRAL and lock the brakes

F. Check to see that the PTO lever and all other systems controls are in the OFF or NEUTRAL positions

G. Turn on fuel supply, but DO NOT OPEN THROTTLE

(NOTE: If the tractor has not been operated for several weeks, turn the engine over a few times with the starter before opening the fuel stop. This lubricates the engine.)

H. Turn starter to ON position

(NOTE: In cold weather, use cold weather starting aids. See operator's manual.)

I. Depress clutch

J. Crank engine several revolutions

(NOTE: Crank device may be a button, lever, combination ignition and starting key, or gear lever positon. See operator's manual.)

(CAUTION: Do not crank engine for more than twenty seconds. Allow engine to cool for at least two minutes before attempting to start the tractor again.)

JOB SHEET #4

K. Open throttle from one-half position to completely open

(NOTE: Do not open throttle until starter has engine rotating. This keeps fuel from entering the cylinders too soon, which can cause the engine to "kick back" and damage the starter drive mechanism.)

L. Release clutch SLOWLY

M. Check oil pressure gauge

N. Check ammeter to see that battery is charging

O. Watch engine coolant temperature gauge to determine when engine is warmed

P. To shut down, allow engine to idle three to four minutes

(NOTE: This permits the engine to cool down and allows for gradual and uniform cooling of engine parts. It also prevents damage to the turbocharger by allowing it to slow down. If parking briefly and returning to work, let engine idle at one-half throttle or faster.)

Q. Place gearshift lever in PARK or NEUTRAL and lock brakes

R. Lower implements

S. Disengage all other drives

T. Turn off all electrical switches

U. Completely retard throttle

V. Turn off key or electrical system master switch

W. Remove key

X. Dismount properly

(CAUTION: Wait for all moving parts to stop before dismounting.)

TRACTORS
UNIT IX

JOB SHEET #5--STOP A TRACTOR

I. Equipment

  A. Tractor

  B. Operator's manual

II. Procedure

  A. Check operator's manual for procedures and controls

  (NOTE: Start preparing to stop far in advance and look for possible hazards. Avoid sudden stops.)

  B. Retard the throttle and apply brakes *gradually*

    1. Synchronized transmission--*Gradually* move the control lever to NEUTRAL position

    (NOTE: The transmission acts as a brake. Sudden movements of the control lever will skid the tires or put heavy loads on the drive train.)

    2. Power-assisted or hydraulic transmission--Downshift or depress inching pedal before applying brakes

  C. Depress clutch and move gearshift lever to NEUTRAL or PARK

  (NOTE: Do not put transmission in PARK until tractor comes to a complete stop.)

  D. Release clutch pedal

  E. If tractor is equipped with foot brake, press brake down and lock for parking

  F. If engine is to idle, set speed-control lever at fast idle

  (NOTE: For gasoline engines, set at one-fourth to one-third throttle; for diesel engines, set at one-half throttle.)

  G. Follow procedures for engine shutdown

TRACTORS
UNIT IX

JOB SHEET #6--OPERATE A TRACTOR

I. Equipment

   A. Tractor

   B. Operator's manual

II. Procedure

   (CAUTION: Be sure you know how to stop the tractor before operating it.)

   A. Check manufacturer's recommendations regarding shifting

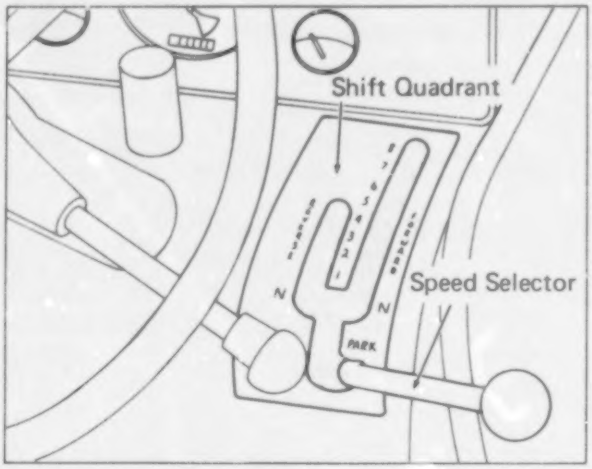
   B. Start and warm up engine

   C. Depress clutch pedal

   D. Select speed range in which you wish to operate if tractor is equipped with speed range selector (Figure 31)

   (NOTE: You MUST STOP THE TRACTOR to change the speed range.)

FIGURE 31



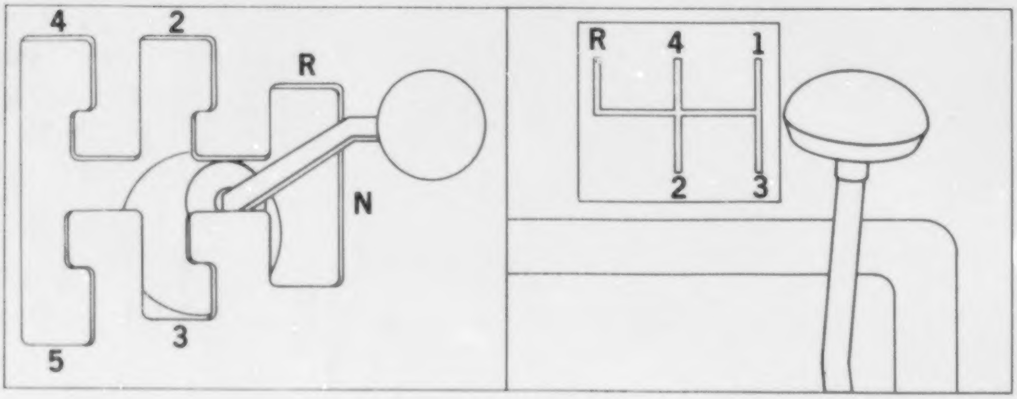
Used with permission of the American Association For Vocational Instructional Materials, Athens, Georgia.

JOB SHEET #6

E. Place transmission in gear (Figure 32)

(NOTE: Hand-shifted manual or synchronized transmissions may have a lever that works within the various slots and notches of a forward or reverse quadrant, or a lever that is positioned according to a chart showing gear positions.)

FIGURE 32



Used with permission of the American Association for Vocational Instructional Materials, Athens, Georgia.

1. Manual transmission

   a. Select gear in which you wish to operate and place tractor in gear

   (NOTE: Start out in the gear in which you will drive or operate. To shift gears, you must stop the tractor.)

   b. Operate tractor at medium to fast idle and SLOWLY release clutch pedal

   c. Move throttle to desired operating speed after clutch is fully released

   (CAUTION: Never attempt to shift a manual transmission while the tractor is in motion.)

2. Synchronized transmission

   a. Place transmission in gear

   b. SLOWLY release clutch with engine at a slow to fast idle speed

   c. Move throttle to desired operating position after clutch is fully released

JOB SHEET #6

d. To shift gears while tractor is in motion, depress clutch pedal and move gearshift lever to desired gear

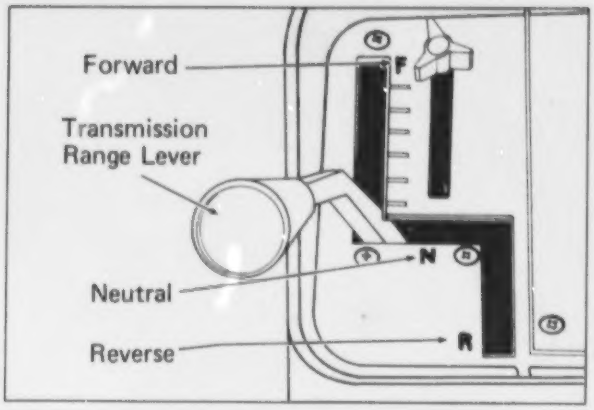
(NOTE: The gears may take a few seconds to engage. Keep a steady pressure on the lever until it slides into position.)

e. SLOWLY release clutch

3. Power-assisted or hydraulic transmission (Figure 33)

(NOTE: In this transmission, the inching pedal replaces the clutch pedal. It is not used for shifting gears but for creeping speeds when attaching implements, for making slow starts, and for emergency stops. It is possible to "skip" gears while shifting, but this results in a jerky motion. For safety, it is best to shift the tractor gear by gear.)

FIGURE 33



Used with permission of the American Association for Vocational Instructional Materials, Athens, Georgia.

a. Place gearshift lever into low gear or reverse while engine is running at slow to moderate speed

b. Move lever, gear by gear, to desired operating position and increase throttle speed

F. Drive tractor forward

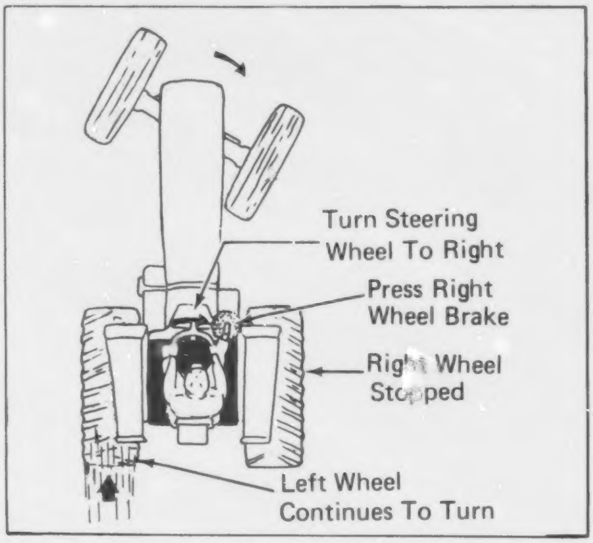
JOB SHEET #6

G. Make a right turn (Figure 34)

(NOTE: Turns are made by turning the steering wheel and pressing on the individual wheel brake to assist the turn, especially for short turns.)

(CAUTION: Do not make short turns while towing an attachment. You may jackknife.)

FIGURE 34


Turn Steering Wheel To Right
Press Right Wheel Brake
Right Wheel Stopped
Left Wheel Continues To Turn

Used with permission of the American Association for Vocational Instructional Materials, Athens, Georgia.

H. Make a left turn

I. Drive forward

J. Stop tractor

K. Look to rear to check for obstacles, persons, or hazards

L. Depress clutch

M. Place gearshift in reverse

(CAUTION: Never shift from forward gears to reverse or from reverse to forward gears while the tractor is in motion.)

N. Back at a slow speed

(CAUTION: Never back any farther than necessary.)

JOB SHEET #6

O. Stop tractor

P. Place gearshift lever in PARK or NEUTRAL; lock brakes

Q. Shut down tractor

DOT I - 817

TRACTORS
UNIT IX

JOB SHEET #7--ATTACH IMPLEMENT TO A DRAWBAR

I. Equipment

A. Tractor with drawbar

B. Implement

II. Procedure

(NOTE: Accidents are common in this operation. Avoid injuries from the following operations:

Lifting--Know the proper way to lift heavy objects

Cutting--Wear gloves when handling sharp objects

Pinching--Use caution when connecting and disconnecting joints; keep hands and fingers out of joints

Crushing--Keep feet out from under equipment.)

A. Read operator's manual thoroughly

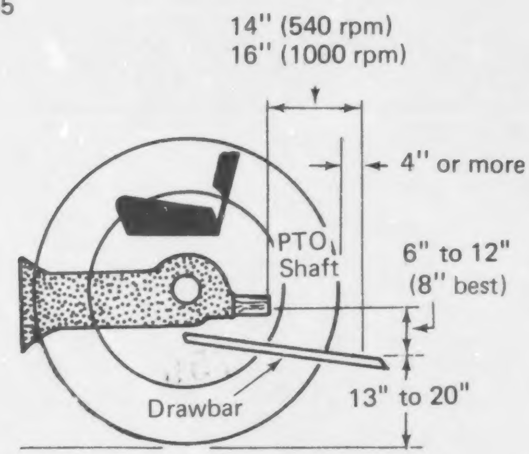
B. Adjust drawbar height to approximately 16 inches clearance between ground level and drawbar hitch point by performing one of the following (Figure 35)

1. Turn drawbar over

2. Adjust drawbar bracket

3. Adjust drawbar frame assembly where it bolts to tractor frame

FIGURE 35



Used with permission of Deere & Company, Moline, Illinois.

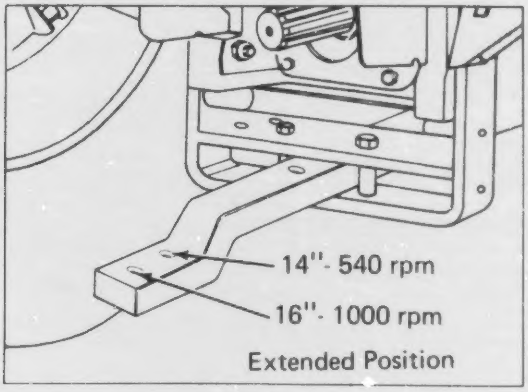
JOB SHEET #7

C. Use hitch in extended position (Figure 36)

   1. For power takeoff speed of 540 rpm, hitch point must be *14 inches* from end of the PTO shaft

   2. For power takeoff speed of 1000 rpm, hitch point must be *16 inches* from end of the PTO shaft

FIGURE 36



Used with permission of the American Association for Vocational Instructional Materials, Athens, Georgia.

D. Center drawbar hitch point directly under PTO shaft; fasten it securely

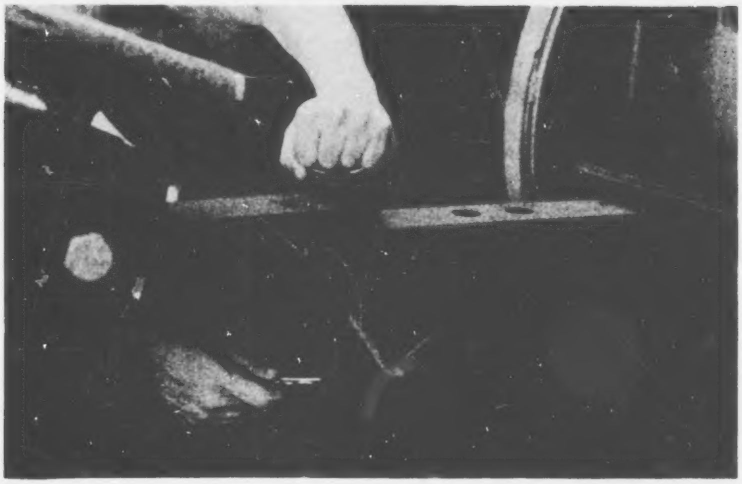
E. Back tractor into position so that hole in drawbar is in line with hole in implement hitch

F. If on sloping ground, set and lock tractor brakes

JOB SHEET #7

G. Set pin in place (Figure 37)

FIGURE 37



(NOTE: Do not try to position tractor by operating the transmission controls from the ground. You may get pinned between the tractor and the implement. If you cannot insert the hitch pin by moving the implement, get back on the tractor and realign the drawbar with the holes in the hitch. Be sure you use a cotter pin or some other means of holding the hitch pin in place so that it will not work itself out.)

H. Secure cotter pin or other device

I. Make electrical connections if needed

TRACTORS
UNIT IX

JOB SHEET #8--ATTACH IMPLEMENT TO A THREE-POINT HITCH

I. Equipment

A. Tractor equipped with three-point hitch

B. Operator's manual

C. Implement such as flail mower, rotary mower, or posthole digger

II. Procedure

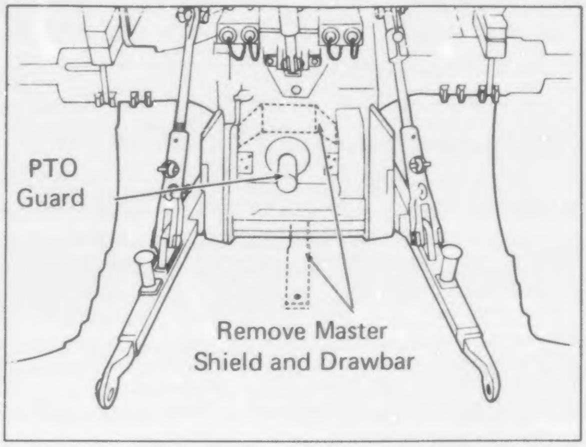
A. Check operator's manual

B. Set rockshaft selector lever to MIN position

C. Check drawbar position to make certain it will not interfere with movement of hitch

(NOTE: Some tractors have no separate drawbar. Others may require that the drawbar be removed or placed in the short position. With short-coupled implements, it may be necessary to remove the master guard over the power takeoff shaft to provide necessary clearance. In that case, BE SURE THE TUBULAR GUARD IS IN POSITION OVER THE STUB POWER SHAFT. See Figure 38.)

FIGURE 38



Used with permission of the American Association for Vocational Instructional Materials, Athens, Georgia.

JOB SHEET #8

D. Back tractor so that lower links are in position to connect to implement hitch pins

   1. If lower links are equipped with ball joints, back tractor so that joints are *over* hitch pins on implement

   2. If lower links are equipped with latches, align so that latches are *under* hitch pins of implement

E. Raise lower hitch with hydraulic remote control to height needed to connect to implement hitch pins

F. Place transmission selection lever in PARK or NEUTRAL

(NOTE: If on sloping ground, set tractor wheel brakes and block wheels)

G. Attach left lower link to left hitch pin of implement (Figure 39)

(NOTE: Always attach *left* lower link first. If lower-link connection is not in line with hitch pin on implement, pull implement ahead, if possible, or rock tractor if it is on level ground. On tractors with extended or telescoped lower links, it is not necessary to rock the tractor or pull on the implement.)

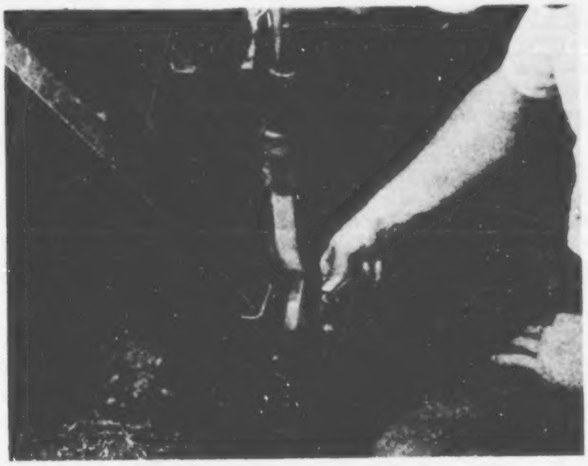
FIGURE 39

Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #8

H. Insert locking pin (Figure 40)

FIGURE 40

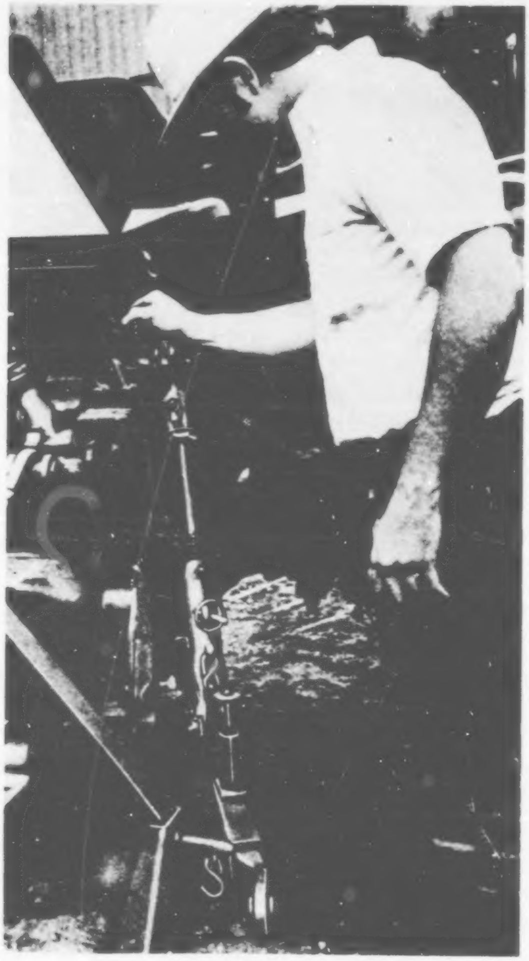


Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #8

I. Raise or lower right lower link to correct height by turning crank (Figure 41)

FIGURE 41



Courtesy of Deere & Company, Moline, Illinois.

J. Attach right lower link; insert pin

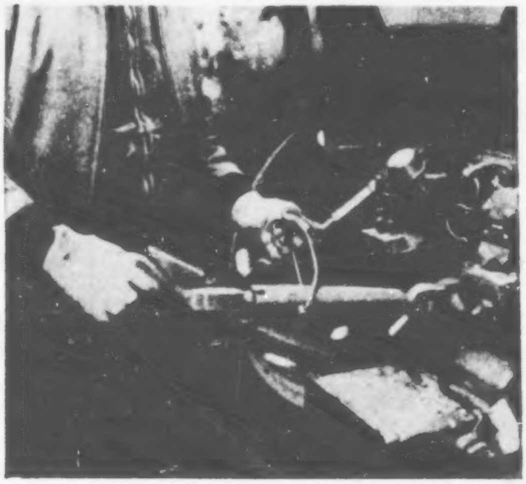
JOB SHEET #8

K. Unhook center link from transport bracket

(NOTE: The center link enables operator to tilt the implement forward or backward to level it from front to rear.)

L. Adjust center link to reach mast by turning outer housing or by using adjusting handle (Figure 42)

FIGURE 42



Courtesy of Deere & Company, Moline, Illinois.

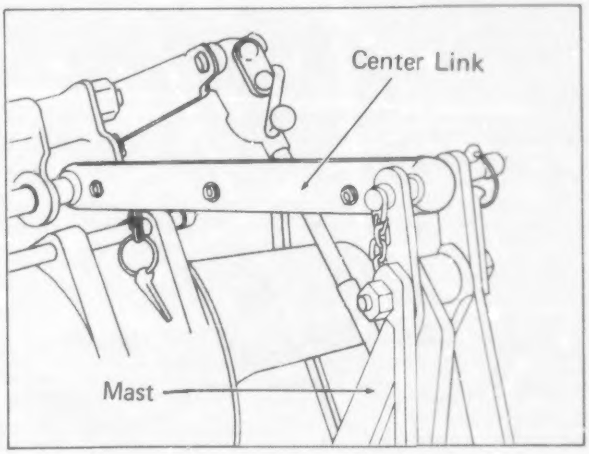
M. Adjust center link so that both shafts inside outer housing are extended equally

JOB SHEET #8

N. Drop center link into implement mast and lock into place by inserting a pin through holes in mast and turnbuckle; fasten pin so that it cannot bounce out of connecting point (Figure 43)

(NOTE: If center link is equipped with a latch assembly, depress lever, fit latch over the ball, and release lever.)

FIGURE 43



Used with permission of the American Association for Vocational Instructional Materials, Athens, Georgia.

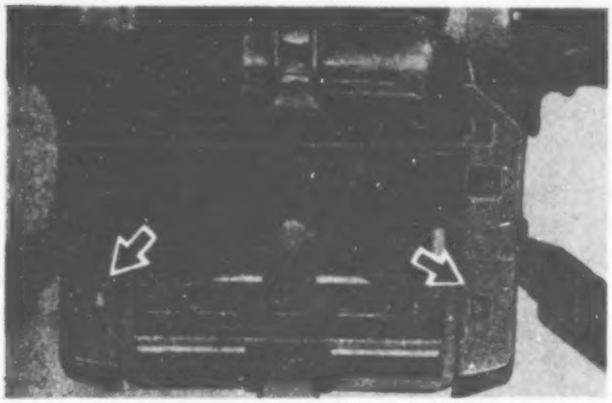
JOB SHEET #8

O. Install sway blocks in lower position with narrow, flat edge, inward (Figure 44)

(NOTE: This will eliminate sway during operation and transport.)

(CAUTION: Be sure lower links do not bind on sway blocks.)

FIGURE 44



Courtesy of Deere & Company, Moline, Illinois.

P. Attach front end weights if required

Q. Raise implement to transport position, using hydraulic control

(NOTE: Make certain that it clears at all points and that the connections are secure.)

TRACTORS
UNIT IX

JOB SHEET #9--ATTACH A POWER TAKEOFF

I. Equipment

  A. Tractor

  B. Implement, preferably equipped with spring-loaded locking device

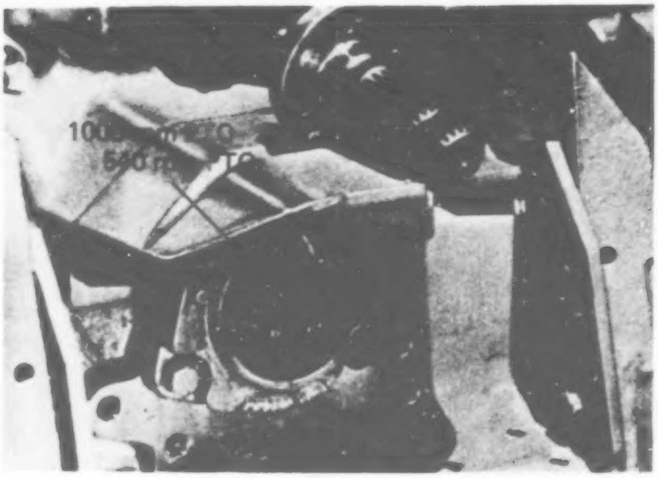
  C. Oil

  D. Rags

II. Procedure

(NOTE: Be sure to have correct rpm PTO shaft for the implement being attached. See Figure 45.)

FIGURE 45



540 rpm--
Six Splines

1000 rpm--
Twenty-one Splines

Courtesy of Deere & Company, Moline, Illinois.

  A. Set wheel brakes

  B. Disengage power to PTO shaft

  C. Shut off engine

  (CAUTION: Always shut off engine and disconnect PTO before attempting to connect or disconnect implements.)

  D. Remove shaft guard if tractor is so equipped

  E. Check tractor PTO coupling and implement PTO stub shaft to make sure that they have the same number of splines; if not, attach the correct stub shaft and manually shift the shaft speed; see manufacturer's instructions

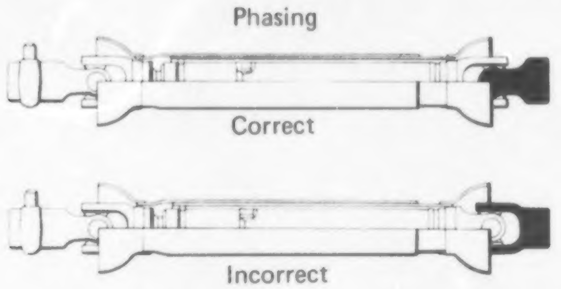
JOB SHEET #9

F. Clean inside of coupling of all grease and debris

G. Oil PTO shaft spline

H. Check that universal joints on powershaft run in same plane (Figure 46)

FIGURE 46

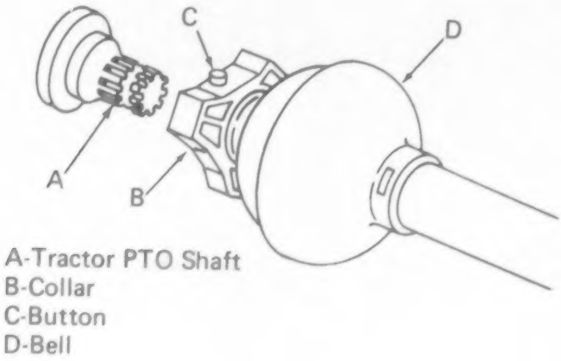

Phasing
Correct
Incorrect

Note Position of Right Hand Joints

Used with permission of Deere & Company, Moline, Illinois.

I. Attach powershaft with a spring-loaded lock (Figure 47)

FIGURE 47


C
D
A
B
A-Tractor PTO Shaft
B-Collar
C-Button
D-Bell

Used with permission of Deere & Company, Moline, Illinois.

J. Move collar (B) back against stop on yoke (See Figure 47)

JOB SHEET #9

K. Turn collar to align yoke with splines on tractor PTO shaft (A) (Figure 47)

(NOTE: Some models will require that you push the button down and turn the collar until the button stays down.)

L. Slide powershaft onto PTO shaft (Figure 48)

FIGURE 48

Courtesy of Deere & Company, Moline, Illinois.

M. Depress pin or button and move shaft forward until collar snaps into locked position (Figure 49)

FIGURE 49

Courtesy of Deere & Company, Moline, Illinois.

N. Check locking device by pulling back on bell or guard shaft (Figure 50)

(NOTE: Do not pull on collar; latch will release.)

FIGURE 50

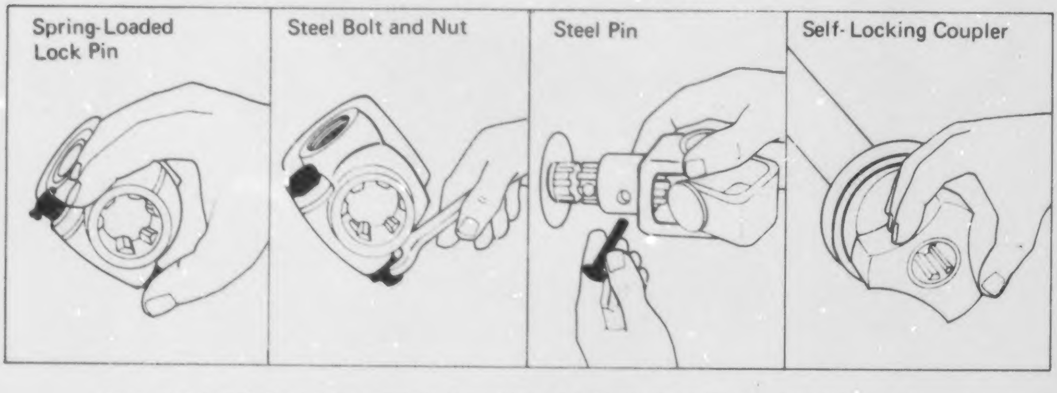
Courtesy of Deere & Company, Moline, Illinois.

O. Slide safety shield into place

P. Keep alignment as straight as possible

(NOTE: Procedures in this job sheet show a spring-loaded lock pin. Several types of locking devices are common. See Figure 51.)

FIGURE 51



Spring-Loaded Lock Pin

Steel Bolt and Nut

Steel Pin

Self-Locking Coupler

Used with permission of the American Association for Vocational Instructional Materials, Athens, Georgia.

Q. Maintain proper drawbar height and length

TRACTORS
UNIT IX

JOB SHEET #10--OPERATE A POWER TAKEOFF

I. Equipment

   A. Tractor

   B. Operator's manual

II. Procedure to engage PTO

   (CAUTION: Engage PTO only when the engine is running.)

   A. Run the engine

   B. Push down clutch pedal all the way

   C. Wait for tractor to stop if necessary

      (NOTE: Some olders tractors must come to a complete stop before PTO is engaged. On newer models, tractors can be moving as PTO is engaged.)

   D. Move PTO lever to ON position

   E. Release pedal slowly

III. Procedure to stop tractor while PTO is running

   (NOTE: This technique is used to change gears and to clean out mowers and augers.)

   A. Push down both brake pedals *and* clutch pedal at the same time

      (NOTE: PTO should keep running.)

   B. Change gears

   C. Release brake pedals

   D. Release clutch pedal slowly

IV. Procedure to disengage PTO

   A. Push down clutch pedal all the way

   B. Move PTO lever to OFF position

TRACTORS
UNIT IX

JOB SHEET #11--REPAIR A TRACTOR TIRE (COLD PATCH)

I. Equipment and materials

- A. Faulty tire tube
- B. Air supply to inflate tire
- C. Repair kit--Scraper, glue, patching material
- D. Knife or scissors
- E. Water trough or soap and water
- F. Brush
- G. Chalk
- H. Patch roller
- I. Valve core removing tool

II. Procedure

- A. Inflate tube fully
- B. Immerse in water trough or brush with soap and water solution to locate leak
- C. Mark leak with chalk
- D. Remove valve core; deflate tube
- E. Scrape area around leak with scraper to fit size of patch
- F. Apply glue to scraped area; let it set up
- G. Cut patch to allow 1/4-inch overlap around hole
- H. Remove backing material from patch
- I. Press patch down on scraped, glued area
- J. Roll patch to eliminate air bubbles
- K. Replace valve core; inflate tube
- L. Test patch by immersing in water or by brushing with soap and water
- M. Remove valve core; deflate tube

  (NOTE: If a tire tractor gets a large puncture or tear, you may fix it temporarily by applying a cold patch, following procedures E-K.)

TRACTORS
UNIT IX

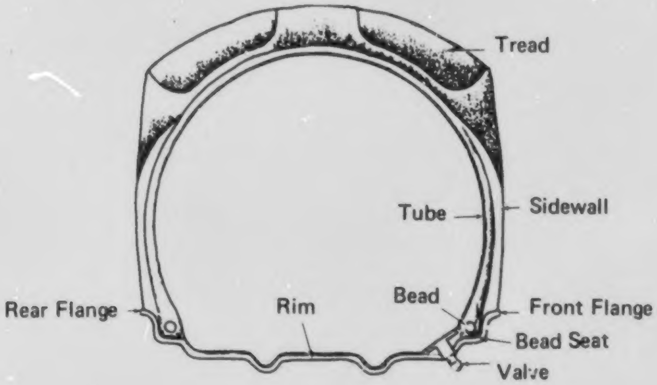
JOB SHEET #12--DEMOUNT A TRACTOR TIRE OFF THE VEHICLE

I. Equipment, materials, and personnel

A. Person to assist

B. Tubed tractor tire (Figure 52)

FIGURE 52


Tread
Tube
Sidewall
Rear Flange
Rim
Bead
Front Flange
Bead Seat
Valve

Tire and Rim

Used with permission of Goodyear Tire and Rubber Company, Akron, Ohio.

C. Mallet

D. Bead unseating tool

E. Two 18-inch tire irons

F. Gloves

G. Wire brush

H. Approved tire mounting lubricant--Vegetable oil, soap, brake fluid, or commercial lubricant

I. Paint brush or rags

J. Wrenches

K. Wire

JOB SHEET #12

II. Procedure

(CAUTION: An inflated tire and the rim on which it is mounted can be very dangerous. Under pressure the tire packs the explosive force of TNT. Never attempt to unseat beads on an inflated tire.)

A. Remove valve core and exhaust ALL air from tire

(CAUTION: A broken rim part under pressure could blow apart and kill you the moment you remove the lugs on the assembly.)

B. Run a wire through valve stem to make sure it is not plugged

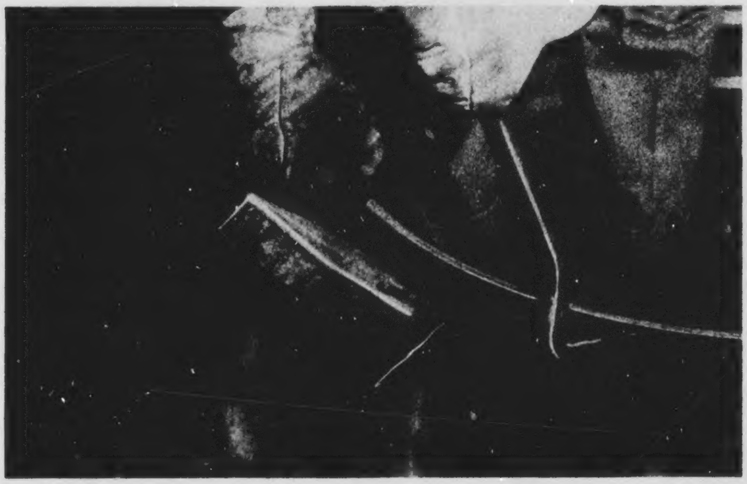
(NOTE: This is done to make sure that ALL air is released.)

C. Remove rim nut and push valve through valve hole

D. Starting at the valve stem, drive bead unseating tool between tire bead and rim to force off bead seat (Figure 53)

(NOTE: Be careful not to damage tire bead area. Do not hit rim with hammer. Beads should be unseated on both sides of the rim.)

FIGURE 53



Courtesy of Deere & Company, Moline, Illinois.

E. Release bead completely around tire

F. Turn tire and rim over; repeat procedure with second bead

JOB SHEET #12

G. Thoroughly lubricate flange, tire bead, and base of tube with a thin solution of vegetable oil soap in water or equivalent rubber lubricant recommended for this procedure (Figure 54)

(NOTE: Never use silicones or petroleum-based solutions.)

FIGURE 54

Courtesy of Deere & Company, Moline, Illinois.

H. Force outside bead into rim well at the bottom

I. Insert long tire irons under bead at the top and pry bead over flange using short bites (Figure 55)

(NOTE: Do not try to pry too large a section of the bead over the flange at one time. Never release grip on either iron because it may spring back.)

FIGURE 55

Courtesy of Deere & Company, Moline, Illinois.

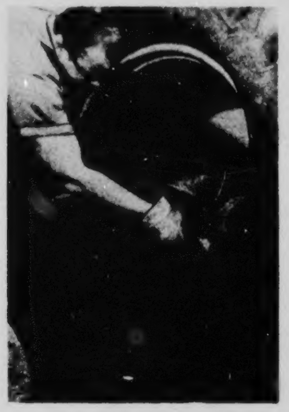
JOB SHEET #12

J. Continue until top bead is completely over the flange

K. Brace tire against a solid support, such as a wall

L. Pull tube out of tire casing (Figure 56)

FIGURE 56



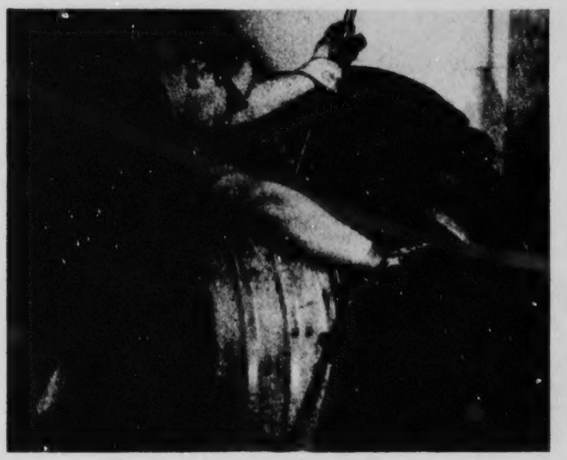
Courtesy of Deere & Company, Moline, Ilinois.

M. Inspect inside of tire casing for foreign material or damage; make sure casing is dry before reinserting tube

N. Be sure one side of bottom bead is in rim well; insert tire irons under opposite side of bead

(NOTE: With smaller size tires, work bottom bead over flange by taking small bites with two tire irons. See Figure 57.)

FIGURE 57



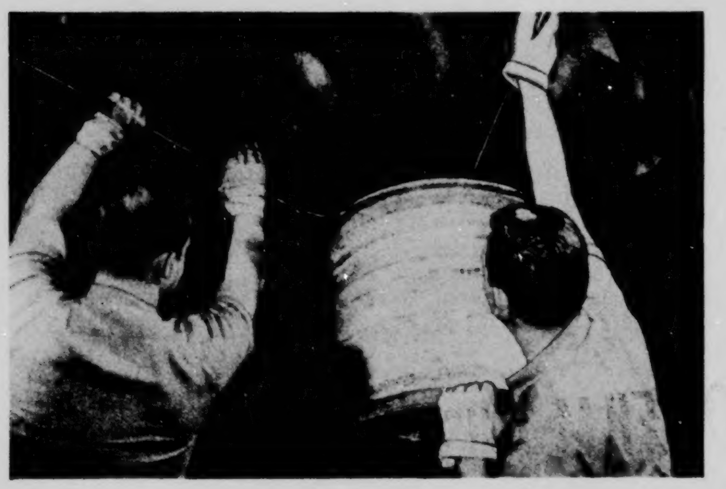
Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #12

O. Stand large, heavy tires on tread

P. Have one person hold rim while second person works second bead over until rim drops out (Figure 58)

FIGURE 58



Courtesy of Deere & Company, Moline, Illinois.

TRACTORS
UNIT IX

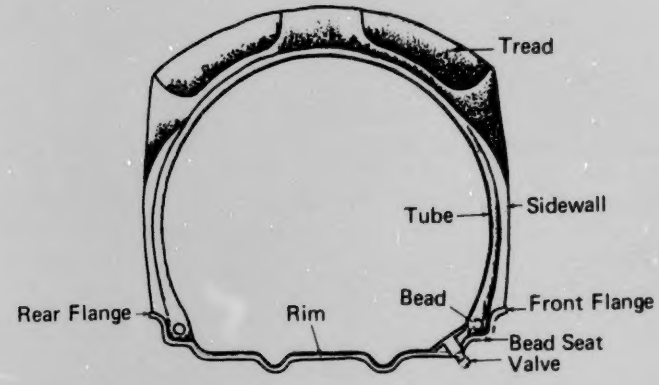
JOB SHEET #13--MOUNT A TRACTOR TIRE OFF THE VEHICLE

I. Equipment, materials, and personnel

A. Person to assist

B. Demounted tractor tire (Figure 59)

FIGURE 59



Tire and Rim

Used with permission of Goodyear Tire and Rubber Company, Akron, Ohio.

C. Two 18-inch tire irons

D. Wire brush

E. Approved tire mounting lubricant--Vegetable oil soap, brake fluid, or commercial lubricant

F. Remote control inflation line with clip-on chuck

G. Inflation gauge

H. Paintbrush or rags

II. Procedure

(CAUTION: Failure to comply with these procedures may result in faulty placement of the tire and/or rim, and cause the assembly to explode with sufficient force to cause serious injury or death.)

A. Check that flange area (particularly the bead seat area) is clean and smooth

JOB SHEET #13

B. Remove any buildup of rust, corrosion, or old rubber with chisel or wire brush

(NOTE: Never mount a tire on a rim where any parts show cracks, damage, or have been repaired by welding or brazing.)

C. Thoroughly inspect inside of casing for damage or foreign material

D. Check to see that both tire and tube are completely dry

(NOTE: Moisture deteriorates the cord fabric of the tire and may eventually cause failure of the tires.)

E. Lay rim on floor with valve hole on top

(NOTE: In the case of a deep well rim, the deep well must always be on top.)

F. Inflate tube until it is rounded out; insert it in tire with valve on top

G. Lubricate bottom tire bead and top flange with a thin solution of vegetable oil soap in water or equivalent rubber lubricant recommended for this procedure

(NOTE: Never use silicones or petroleum-based solutions.)

H. Push bottom bead over flange as far as possible

I. Finger-tighten valve stem rim nut to hold it in place (Figure 60)

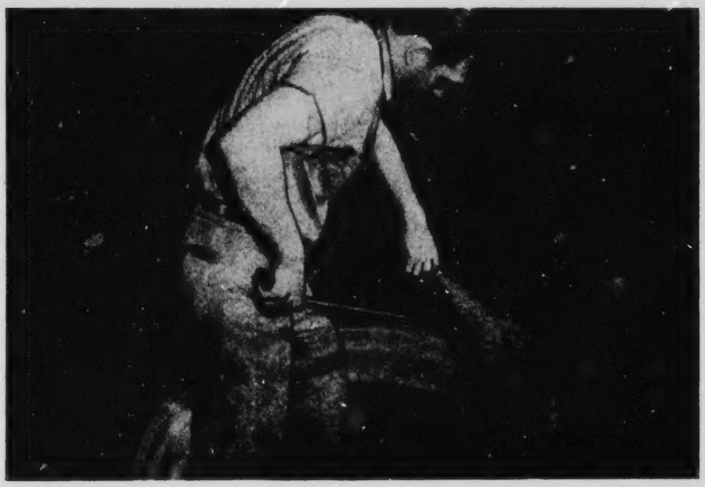
FIGURE 60

Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #13

J. Work first tire bead completely over flange with long tire irons (Figure 61)

FIGURE 61



Courtesy of Deere & Company, Moline, Illinois.

K. Starting opposite the valve, use tire irons to lift top bead over flange and down into rim well

(NOTE: Care must be used to avoid pinching the tube with tire irons.)

L. Get bead started well and lubricate remaining unmounted portion of tire bead and flange (Figure 62)

FIGURE 62

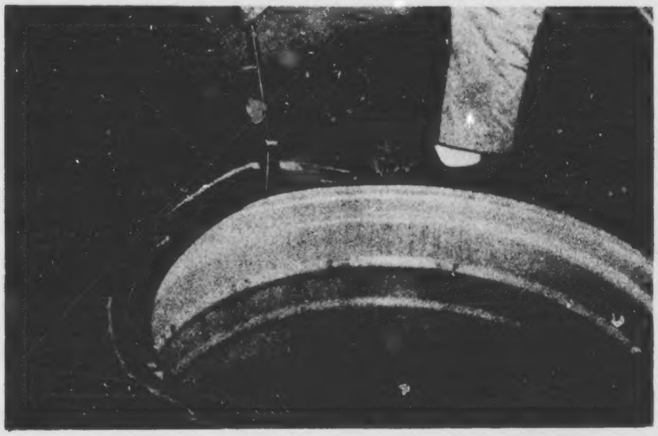
Courtesy of Deere & Company, Moline, Illinois.

M. Force tire bead into rim well when working tire bead over flange

(NOTE: It may be necessary to lift opposite the bead.)

N. Stand on the half of tire that is in rim well and work equally around both sides to spoon tire bead over flange until final section drops over at tube valve (Figure 63)

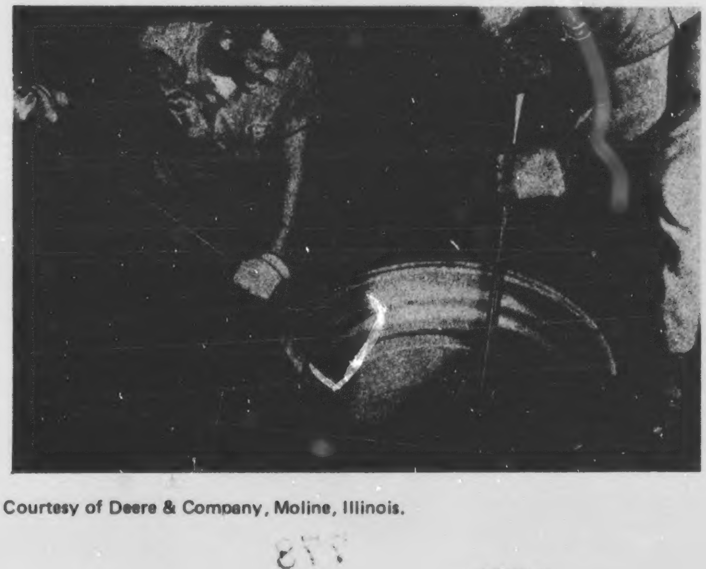
FIGURE 63



Courtesy of Deere & Company, Moline, Illinois.

(NOTE: With large tires, a second person may be required to hold tire bead in rim well--either with tire iron or by standing on the tire sidewall. See Figure 64.)

FIGURE 64



Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #13

O. Center tire on rim; inflate to 35 psi

(CAUTION: Use extension hose with clip-on chuck. Never stand over the tire while inflating it; stand or kneel to one side.)

P. If beads have not seated by the time pressure reaches 35 psi, deflate the assembly, reposition tire on rim, relubricate, and reinflate

(CAUTION: Do not increase inflation pressure to seat beads. More than 35 psi may break the bead or even the rim with enough explosive force to cause serious injury or death.)

Q. Remove valve core housing; completely deflate

R. Reinsert valve core housing; reinflate tire to recommended pressure

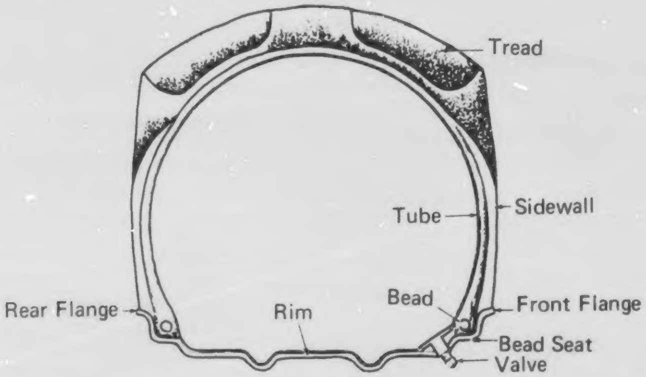
TRACTORS
UNIT IX

JOB SHEET #14--DEMOUNT A TRACTOR TIRE ON THE VEHICLE

I. Equipment, materials, and personnel

- A. Person to assist
- B. Mounted tractor tire (Figure 65)

FIGURE 65


Tread
Tube
Sidewall
Bead
Rear Flange
Rim
Front Flange
Bead Seat
Valve

Tire and Rim

Used with permission of Goodyear Tire and Rubber Company, Akron, Ohio.

- C. Jack
- D. Bead unseating tool
- E. Mallet
- F. Two 36-inch tire irons
- G. Two 18-inch tire irons
- H. Wire brush
- I. Approved tire-mounting lubricant--Vegetable oil soap, brake fluid, or commercial lubricant
- J. Paintbrush or rags
- K. Wrenches
- L. Wire

JOB SHEET #14

II. Procedure

(CAUTION: Failure to comply with these procedures may result in faulty placement of the tire and/or rim, which could cause the assembly to explode with sufficient force to cause serious injury or death.)

A. Jack vehicle up on side which is to have tire removed

B. Lock wheel by putting vehicle into gear with valve at top of tire

C. Remove valve core; exhaust ALL air from tire

D. Run a wire through the valve stem to make sure it is not plugged

E. Remove rim nut and push valve through valve hole

F. Starting at the valve stem, drive bead-unseating tool between tire bead and flange to force off bead seat (Figure 66)

(NOTE: Be careful not to damage tire bead area. Do not hit rim with hammer. Bead should be unseated on both sides of the rim.)

FIGURE 66

Bead-unseating Tool

Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #14

G. Lubricate tire bead area and flange thoroughly with a thin solution of vegetable oil soap in water or equivalent rubber lubricant recommended for this procedure (Figure 67)

(NOTE: Never use silicones or petroleum-based lubricants.)

FIGURE 67

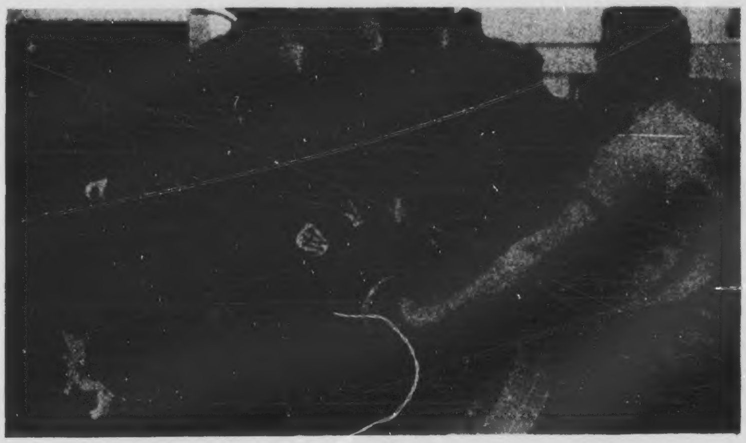
Courtesy of Deere & Company, Moline, Illinois.

H. Force outside bead into rim well at the bottom

I. Insert long tire irons under bead at the top and pry bead over flange (Figure 68)

(NOTE: Take short bites to avoid extremely hard prying, as it is possible to damage tire bead.)

FIGURE 68



Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #14

J. Maneuver first section of bead over flange

K. Use one tire iron to hold that section over flange, and use other tire iron to pry next section over flange (Figure 69)

(NOTE: Do not try to pry too large a section of the bead over the flange at one time. Never release grip on either iron, because it may spring back.)

FIGURE 69

Courtesy of Deere & Company, Moline, Illinois.

L. Pull tube out of casing, starting at bottom (Figure 70)

(NOTE: If only tube requires repair or replacement, it can be removed, repaired, and replaced in casing without removing tire completely from wheel.)

FIGURE 70

Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #14

M. Thoroughly inspect inside of casing for damage or foreign material; remove any fluid from inside of tire

N. Insert tire irons under inside bead at *side* of tire to remove tire completely (Figure 71)

(NOTE: When starting this operation, be sure that bead area on opposite side of the tire is down in well of rim.)

FIGURE 71

Courtesy of Deere & Company, Moline, Illinois.

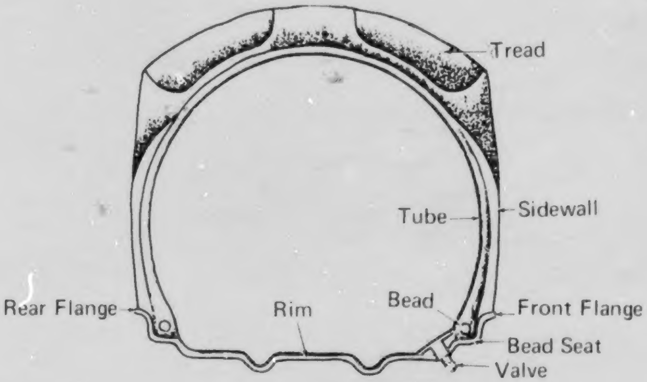
TRACTORS
UNIT IX

JOB SHEET #15--MOUNT A TRACTOR TIRE ON THE VEHICLE

I. Equipment and materials, and personnel

- A. Person to assist
- B. Tractor, jacked up and secured, with tire removed
- C. Tire (Figure 72)

FIGURE 72


Tread
Tube
Sidewall
Rear Flange
Rim
Bead
Front Flange
Bead Seat
Valve

Tire and Rim

Used with permission of Goodyear Tire and Rubber Company, Akron, Ohio.

- D. Mallet
- E. Two 36-inch tire irons
- F. Two 18-inch tire irons
- G. Wire brush
- H. Approved tire mounting lubricant--Vegetable oil soap, brake fluid, or commercial lubricant
- I. Remote control inflation line with clip-on chuck
- J. Inflation gauge
- K. Wrenches
- L. Paintbrush or rags

JOB SHEET #15

II. Procedure

(CAUTION: Failure to comply with these procedures may result in faulty placement of the tire rim, and cause the assembly to explode with sufficient force to cause serious injury or death.)

A. Check that flange area (particularly bead seat area) is clean and smooth

B. Remove any buildup of rust, corrosion, or old rubber with chisel or wire brush

(NOTE: Never mount a tire on a rim where any parts show cracks or damage or have been repaired by welding or brazing.)

C. Thoroughly inspect inside of casing for damage or foreign material

D. Check to see that both tire and tube are completely dry

(NOTE: Moisture deteriorates the cord fabric of the tire and may eventually cause failure of the tire.)

E. Lubricate both beads and flanges with a thin solution of vegetable oil soap in water or equivalent rubber lubricant recommended for this procedure

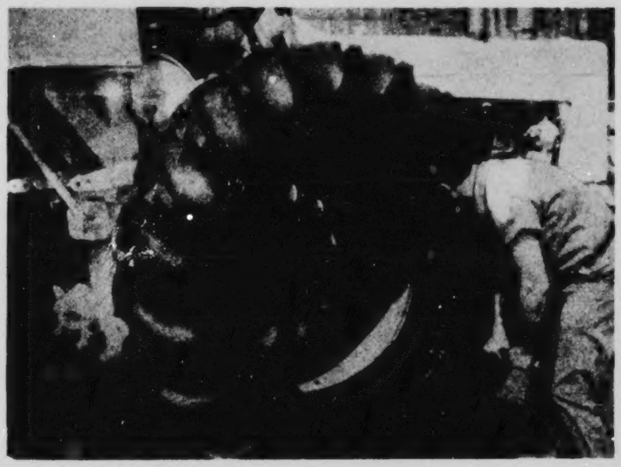
(NOTE: Never use silicones or petroleum-based solutions.)

F. Make sure valve hole of rim is at bottom of wheel

G. Place inner bead of tire over flange at top (Figure 73)

(NOTE: Be sure inner bead is not hung up on bead seat. Guide into rim well as tire irons work first bead over the rim.)

FIGURE 73



Courtesy of Deere & Company, Moline, Illinois.

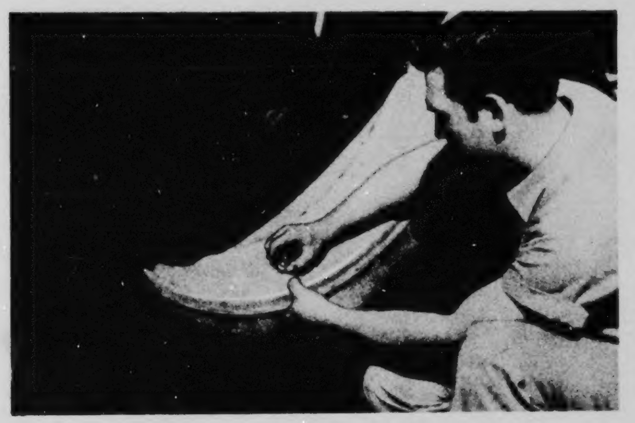
JOB SHEET #15

H. Pull tire toward outside of rim as far as possible to make room for tube

I. Check to see that tube valve is at bottom of wheel

J. Align stem with valve hole and place tube in tire, starting at the bottom (Figure 74)

FIGURE 74



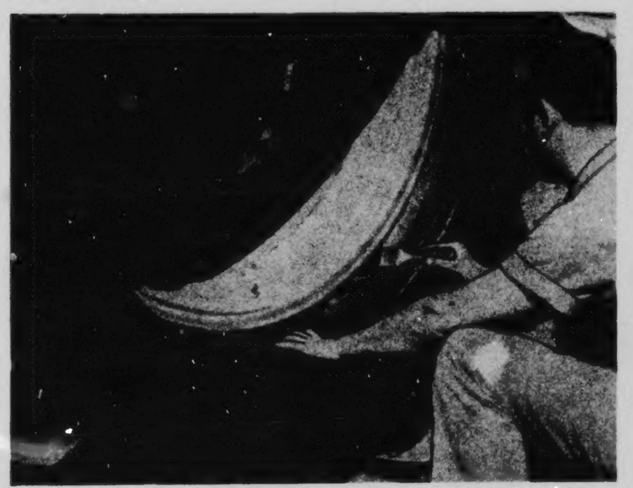
Courtesy of Deere & Company, Moline, Illinois.

K. Be sure that tube is well inside rim before proceeding to next step

L. Partially inflate tube

M. To prevent localized stretching, lubricate base area of tube that contacts rim (Figure 75)

FIGURE 75



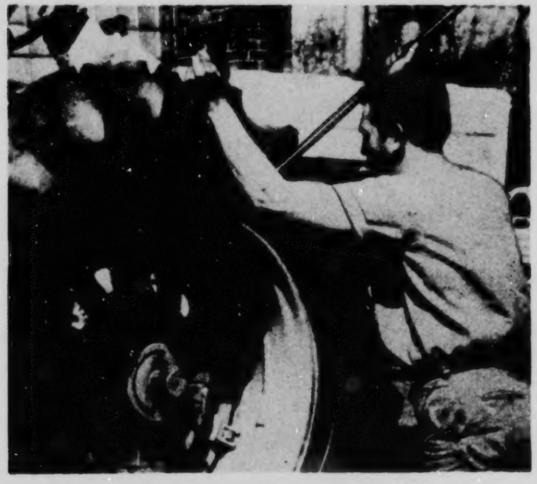
Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #15

N. Starting at top, opposite the valve stem, use tire irons to lift outer bead up and over flange and down into rim well (Figure 76)

(CAUTION: Be careful not to pinch tube.)

FIGURE 76

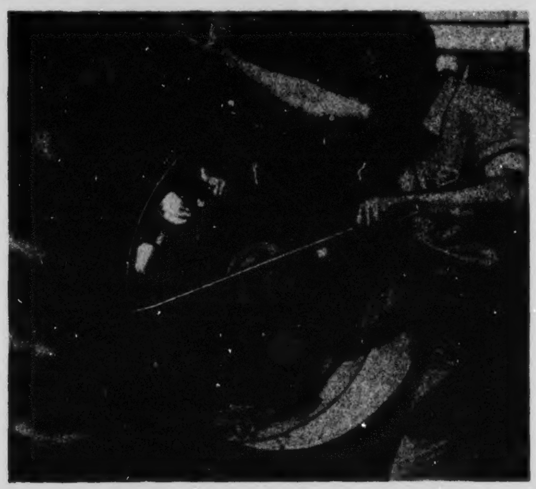


Courtesy of Deere & Company, Moline, Illinois.

O. Place one hand against first section to hold it; then pry remainder of bead over flange with tire iron in the other hand (Figure 77)

(NOTE: Do not attempt to pry large sections of bead over flange at one time.)

FIGURE 77



Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #15

P. Lubricate rim bead seats as well as tire beads

Q. Rotate tire so that valve stem is at bottom of tire

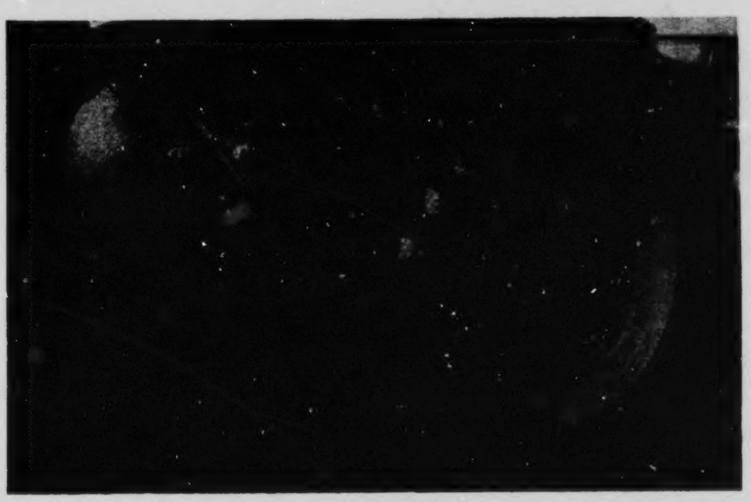
R. Lower jack until tire is centered on rim

(NOTE: Centering of the tire and rim assembly is extremely important to prevent broken beads.)

S. Inflate sufficiently to seat beads on rim at bottom (Figure 78)

(CAUTION: Use extension hose with clip-on chuck. Never stand over the tire while inflating it. Stand or kneel to one side. DO NOT EXCEED 35 psi.)

FIGURE 78



Stay Clear of Tire

Courtesy of Deere & Company, Moline, Illinois.

T. Raise tractor

U. Rotate tire so that valve is at top

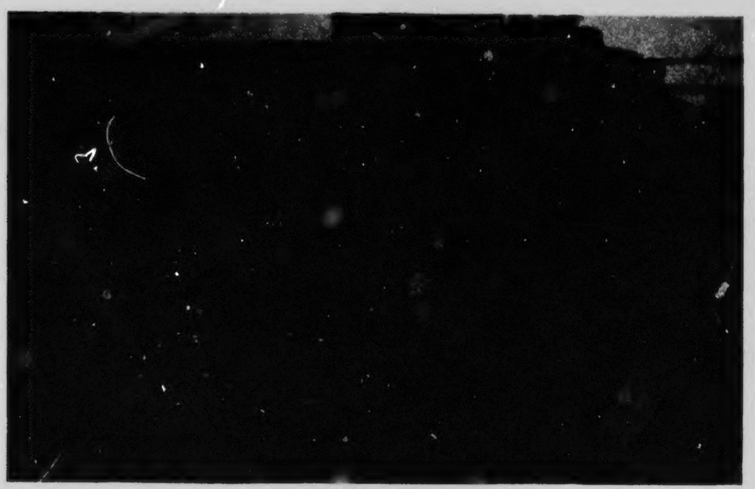
V. Check tire pressure

JOB SHEET #15

W. If pressure is below 35 psi, inflate to 35 psi to seat beads fully (Figure 79)

(CAUTION: Do not exceed 35 psi.)

FIGURE 79



Stay Clear of Tire

Courtesy of Deere & Company, Moline, Illlinois.

X. If beads have not seated by the time pressure reaches 35 psi, deflate assembly, reposition tire on rim, relubricate, and reinflate

(CAUTION: Do not increase pressure to seat beads. More than 35 psi may break the bead or even the rim with enough explosive force to cause serious injury or death.)

Y. Remove valve core housing; completely deflate tire

Z. Reinsert valve core housing; reinflate to recommended pressure

AA. Lower and remove jack

TRACTORS
UNIT IX

TEST

NAME ____ SCORE __________

1. Match terms associated with tractor operation to their correct definitions. Write the correct numbers in the blanks.

_____a. To travel equipment under its own power

_____b. Load-pulling capacity

_____c. Parallel grove running lengthwise on a shaft

_____d. Exhaust-driven centrifugal air compressor; used to increase power

_____e. Controls for equipment mounted on a three-point hitch

_____f. Part of tire that fits against the rim

_____g. To travel equipment by loading it on another vehicle

_____h. Tool attached to tractor to do a specific job

_____i. Mechanical connection on an engine or transmission to which a cable, belt, or shaft can be connected to drive an attachment or tool

_____j. To cause two surfaces to fit firmly together

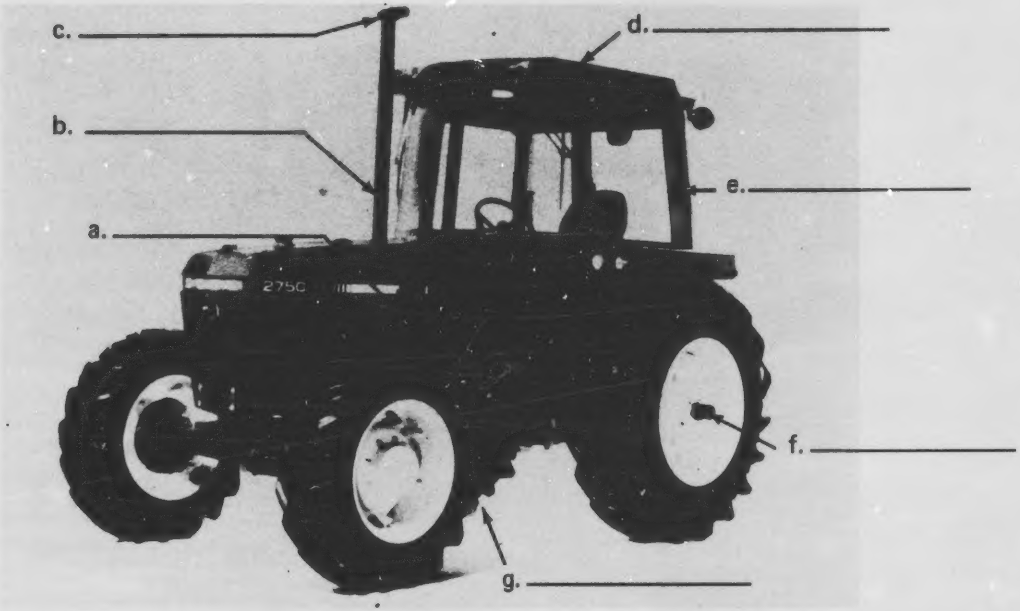
_____k. To slow down

_____l. Equipped with hydraulically powered controls

1. Implement
2. Spline
3. Bead
4. Transport
5. Hydrostatic
6. Turbocharger
7. Road
8. Rockshaft system
9. Draft
10. Retard
11. Power takeoff (PTO)
12. Seat

TEST

2. Label parts of a tractor. Write the correct names in the blanks.


c. ______
d. ______
b. ______
e. ______
a. ______
2750
f. ______
g. ______

TEST

3. Identify controls on a typical tractor. Write the correct numbers in the blanks.

_____a. Speed/hourmeter (rpm and hours of operation

_____b. Brake pedals

_____c. Fuel shutoff valve (diesel)

_____d. Rockshaft control lever

_____e. Power takeoff clutch lever

_____f. Hand throttle

_____g. Rockshaft selector lever

_____h. Clutch or inching pedal

_____i. Engine oil pressure gauge

_____j. Ammeter

_____k. Differential lock pedal

_____l. Engine temperature gauge

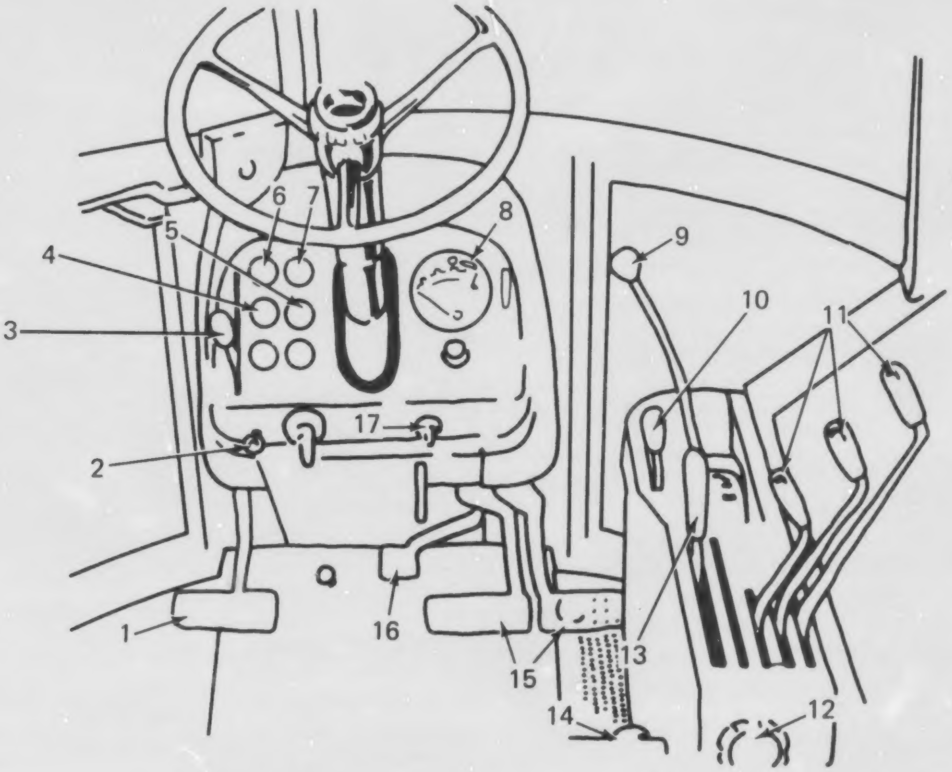
_____m. Ignition key and starter switch

_____n. Rockshaft stop-adjusting knob

_____o. Fuel gauge

_____p. Remote hydraulic operating levers

_____q. Shift lever



TEST

4. Match movement controls on a tractor to their correct functions. Write the correct numbers in the blanks.

_____a. Turns both rear wheels at the same speed

_____b. Regulate flow of fuel to engine

_____c. Stops flow of fuel to injection pump

_____d. Stop tractor and assist in turning

1. Fuel shutoff valve (diesel engines only)
2. Hand and foot throttles
3. Brake pedals
4. Differential lock pedal

5. Match implement controls on a tractor to their correct descriptions. Write the correct numbers in the blanks.

_____a. Regulates the speed at which implement is raised or lowered

_____b. Regulate remote hydraulic cylinders for raising or lowering towed implements

_____c. Controlled by double-acting clutch

_____d. Controlled by a separate drive; will operate with tractor in motion, at a standstill, starting, or stopping

_____e. Sets load and depth sensitivity

_____f. Raises and lowers the hydraulic draft links on a three-point hitch

_____g. Clutch engages or disengages power shaft and transmission shaft at same time; operates only when clutch is engaged

1. Remote controls
2. Rockshaft control lever
3. Independent PTO
4. Transmission-driven PTO
5. Continuous-running PTO
6. Rockshaft selector lever
7. Rockshaft speed control

6. Match types of tractor transmissions to their correct descriptions. Write the correct numbers in the blanks.

_____a. Has no clutch; uses an inching pedal for shifting, operating implements, and hard pulls

_____b. Operating gear is selected, and clutch is engaged to shift; must stop tractor to shift gears

_____c. Can change gear ranges while tractor is in motion

_____d. Clutch is engaged to shift gears while in motion

1. Synchronized
2. Manual
3. High-low shift
4. Power-assisted or hydraulically engaged

TEST

7. Select from the following list principles of brake operation. Write an "X" in the blank before each correct answer.

______a. A single brake pedal controls brakes to left wheel and right wheel

______b. Brakes should be used with a pumping action when going down steep hills

______c. A left brake pedal and a right brake pedal control brakes to left wheel and right wheel

______d. Locked brakes are used for emergency stops and for parking the tractor

______e. Locked brakes are required in rough terrain

______f. Brakes should always be applied *gradually*

______g. Brakes should always be applied *quickly*

______h. Brakes operate independently, or they can be locked together

______i. Brakes operated together assist in making short turns

______j. Brakes operated independently assist in making short turns

______k. Brakes must be adjusted evenly and checked regularly

______l. Brakes *must* be locked when traveling on roads or highways

______m. Brakes must not be locked when traveling on roads or highways

8. State seven safety rules for operating tractors.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

TEST

9. Select from the following list procedures for effective tractor operation. Write an "X" in the blank before each correct answer.

______a. Maintain maximum speed

______b. Perform prestart inspection and maintenance procedures

______c. SLOW DOWN before a turn

______d. Stay clear of ditches, embankments, and excavations

______e. When roading tractor, cover rain cap to protect turbocharger

______f. Take care when entering highway

______g. On the highway, observe speed limits

______h. Drive tractor with two wheels on the shoulder and two on the road

______i. Follow departmental preventive maintenance program

______j. Do not touch electrical wires with any part of the tractor

______k. Road tractor with PTO engaged

______l. When transporting tractor, cover rain cap to protect turbocharger

______m. Shift gears while tractor is in motion

______n. Avoid sudden starts, stops, and turns

______o. Shut engine off imediately after work operation to conserve fuel

______p. Keep speed down

______q. Adjust speed for highway travel

10. Select from the following list procedures for operating a tractor on slopes or hills. Write an "X" in the blank before each correct answer.

______a. Engage the clutch *quickly* when driving out of a ditch, gully, or up a steep slope

______b. Do not drive up hills if you can avoid them

______c. Turn steering DOWNHILL if tractor starts to tilt while on a slope

______d. Take tractor out of gear when going downhill

______e. Engage the clutch *slowly* when driving out of a ditch, gully, or up a steep slope

TEST

______f. Go up steep slopes in reverse

______g. Keep tractor in gear when going downhill

______h. Reduce speed

______i. Turn steering UPHILL if tractor starts to tilt while on a slope

______j. Do not go downhill with heavy loads

11. State five saftey rules for operating the hydraulic system.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

12. State six safety rules for power takeoffs.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

TEST

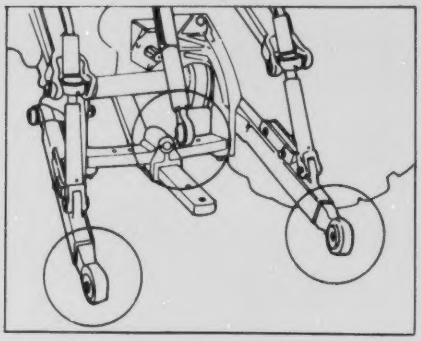
13. Identify types of hitches. Write the correct numbers in the blanks.

______a. Drawbar

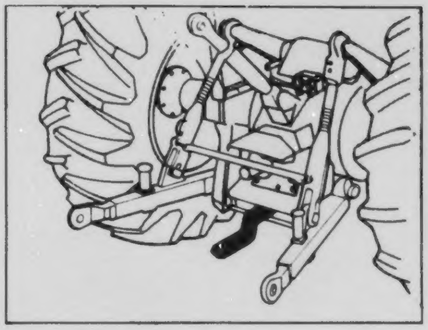
______b. Three-point hitch

______c. Drawbar and three-point hitch

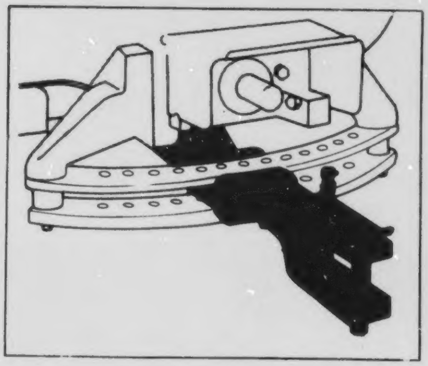
______d. Drawbar as three-point hitch



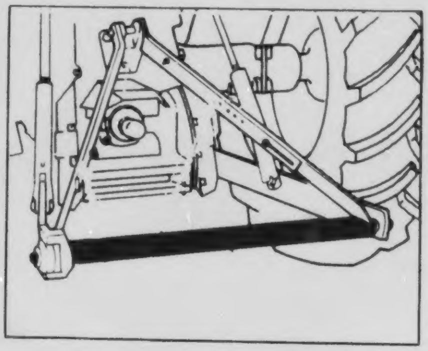
1)



2)



3)



4)

TEST

14. Match adjustments to the drawbar to their correct descriptions. Write the correct numbers in the blanks.

______a. Fourteen inches for 540 rpm, 16 inches for 1000 rpm

______b. Leave 13 to 20 inches ground clearance, measured from top of drawbar

______c. Short position or extended position

______d. Swinging position for operation; fixed position for transporting

______e. Drawbar hitch point parallel with PTO shaft center line

1. Drawbar height
2. Lateral adjustment
3. PTO alignment
4. PTO speed shaft
5. Length

15. Match parts of a three-point hitch to their correct functions. Write the correct numbers in the blanks.

______a. Adjusts length of center link to fit implement

______b. Permit implement to swing freely during operation

______c. Attach to implement; provide pull

______d. Raise or lower implement during operation

______e. Adjust height of hitch to implement

______f. Raises or lowers right lift link level with left lift link for attaching implement

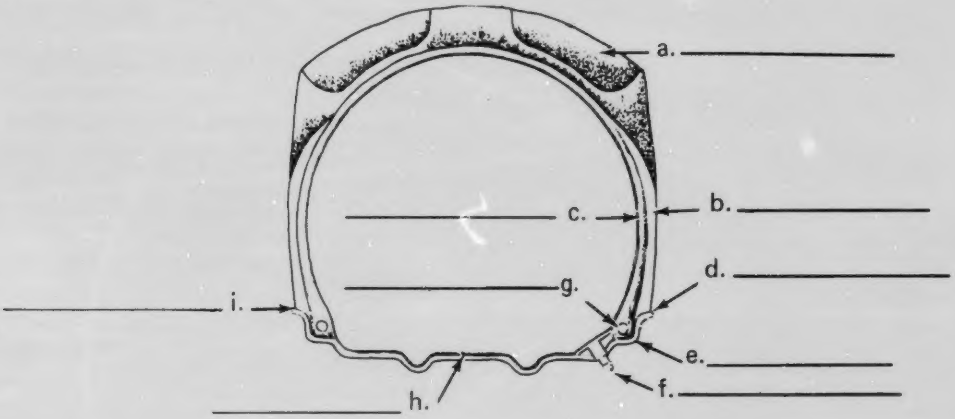
______g. Attaches to implement

1. Rockshaft lift arms
2. Sway blocks
3. Lift link adjusting handle
4. Center link adjusting handle
5. Center link
6. Lift links
7. Lower links or draft links

TEST

16. Identify parts of a tractor tire. Write the correct names in the blank.

Rear flange
Bead seat
Valve
Rim
Front flange
Tube
Bead
Tread
Sidewall



17. Select from the following list safety rules for changing a tractor tire. Write an "X" in the blank before each correct answer.

______a. Keep a "safe body" attitude

______b. Follow recommended procedures

______c. Exhaust ALL air from tire

______d. Use only proper equipment and tools

______e. Use hydraulic tools on larger tires

______f. Inspect and clean all surfaces

______g. NEVER attempt to unseat beads of an inflated tire

(NOTE: Test questions 18-20 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

18. Construct a list of general safety rules for the tractor operator.

19. Classify the parts of a three-point hitch.

TEST

20. Demonstrate the ability to

    a. Perform prestart inspection and maintenance procedures.

    b. Service a tractor.

    c. Start, warm up, and shut down a gasoline-powered tractor engine.

    d. Start, warm up, and shut down a diesel-powered tractor engine.

    e. Stop a tractor.

    f. Operate a tractor.

    g. Attach implement to a drawbar.

    h. Attach implement to a three-point hitch.

    i. Attach a power takeoff.

    j. Operate a power takeoff.

    k. Repair a tractor tire (cold patch).

    l. Demount a tractor tire off the vehicle.

    m. Mount a tractor tire off the vehicle.

    n. Demount a tractor tire on the vehicle.

    o. Mount a tractor tire on the vehicle.

TRACTORS
UNIT IX

ANSWERS TO TEST

1. a. 7
   - b. 9
   - c. 2
   - d. 6
   - e. 8
   - f. 3
   - g. 4
   - h. 1
   - i. 11
   - j. 12
   - k. 10
   - l. 5

2. a. Engine
   - b. Exhaust pipe
   - c. Rain cap
   - d. Cab
   - e. Rollover protective structure (ROPS)
   - f. Axle
   - g. Mounting steps

3. a. 8
   - b. 15
   - c. 2
   - d. 13
   - e. 3
   - f. 10
   - g. 14
   - h. 1
   - i. 4
   - j. 5
   - k. 16
   - l. 7
   - m. 17
   - n. 12
   - o. 6
   - p. 11
   - q. 9

4. a. 4
   - b. 2
   - c. 1
   - d. 3

5. a. 7
   - b. 1
   - c. 5
   - d. 3
   - e. 6
   - f. 2
   - g. 4

ANSWERS TO TEST

6. a. 4
   b. 2
   c. 3
   d. 1

7. c, d, f, h, j, k, l

8. Answer should include any seven of the following
   a. Read the operator's manual thoroughly and know the machine
   b. Study departmental safety manual
   c. Wear close-fitting clothing
   d. Wear ear protection if needed
   e. Provide for ventilation
   f. Become familiar with controls
   g. Do not let another person on or near the tractor when it is in operation
   h. Remove or tie down loose tools and equipment
   i. Keep seat belt fastened
   j. Stay seated during operation
   k. Use all lights and safety warning devices
   l. Check brakes
   m. Disengage PTO when not operating attachment
   n. Do not smoke while working on tractor

9. b, c, d, f, i, j, l, n, p, q

10. b, c, e, f, g, h, j

11. Answer should include any five of the following
    a. Use caution when working with hydraulic system
    b. Wear gloves; use a blocking material such as cardboard or rags when checking hydraulic lines for leaks

ANSWERS TO TEST

c. Stand clear when working with hydraulic lines and tools

d. Keep hydraulic system clean

e. Use proper fittings for hoses and attachments

f. Never depend on the hydraulic system to support machine parts

g. Release pressure from hydraulic system when machine is shut down by moving all levers and steering wheel

h. Avoid prolonged contact with hydraulic fluid

12. Answer should include any six of the following

a. Keep PTO guards and shields in place, even when PTO is not running

b. Always disconnect PTO when not in use

c. Never engage PTO while machine engine is shut off

d. Keep hands, feet, and clothing away from PTO parts

e. Be sure clothing fits snugly

f. Never operate PTO shafts at extreme angles

g. Never ride, or let others ride, on drawbar of tractor

h. Be sure PTO spinner shields rotate freely at all times

i. Always be sure PTO stub shaft is properly secured to machine's powershaft

j. Do not service, lubricate, or perform other work without first disengaging PTO and shutting off tractor engine

13. a. 3)

b. 1)

c. 2)

d. 4)

14. a. 4

b. 1

c. 5

d. 2

e. 3

ANSWERS TO TEST

15. a. 4
    b. 2
    c. 7
    d. 1
    e. 6
    f. 3
    g. 5

16. a. Tread
    b. Sidewall
    c. Tube
    d. Front flange
    e. Bead seat
    f. Valve
    g. Bead
    h. Rim
    i. Rear flange

17. a, b, c, d, f, g

18. Evaluated to the satisfaction of the instructor

19. Evaluated to the satisfaction of the instructor

20. Performance skills evaluated to the satisfaction of the instructor

TRACTOR ATTACHMENTS
UNIT X

UNIT OBJECTIVE

After completing this unit, the student should be able to operate and maintain tractor attachments safely. This knowledge will be shown by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with tractor attachments to their correct definitions.
2. Label tractor attachments and parts.
3. State safety rules for mowing.
4. Select from a list techniques for effective mower operation.
5. Identify parts of a rotary mower.
6. Identify parts of a flail mower.
7. Match parts of a cutter bar to their correct functions.
8. Select from a list general procedures for mower maintenance.
9. Select from a list steps for sharpening mower blades.
10. Select from a list components that need adjusting on a sickle mower cutter bar.
11. Select from a list maintenance procedures for a sickle mower.
12. State safety precautions for operating a posthole digger.
13. Select from a list techniques for operating a posthole digger.
14. Match techniques for operating a posthole digger to correct soil conditions.
15. Demonstrate the ability to
    a. Operate a rotary mower with PTO drive.
    b. Operate a hydraulic rotary mower.
    c. Repair a rotary mower blade.
    d. Operate a flail mower.

OBJECTIVE SHEET

e. Reverse or replace flail mower knives.

f. Adjust cutter bar on a sickle mower.

g. Operate a sickle mower.

h. Replace sickle knife sections.

i. Repair a sickle knife.

j. Operate a posthole digger.

TRACTOR ATTACHMENTS
UNIT X

SUGGESTED ACTIVITIES

I. Suggested activities

A. Order films to supplement unit.

1. *Safe Operation of Farm Tractors*. Color, 16mm, 14 minutes, Cornell University, 1973. Available from Cornell University Film Center, Ithaca, New York 14850.

   (NOTE: This film emphasizes the importance of a safe tractor for the operator. In this film, a young man learns about daily maintenance, protective equipment, road and field hazards, hitches, PTOs, hydraulics, and the necessary skills to become a certified operator under the Occupational Safety and Health Act [OSHA].)

2. *Tractor Tragedies*. Color, 16 mm, 11 minutes, Wyoming University, n.d. Available from Wyoming University, Audio-Visual Services, Box 3273 University Station, Laramie, Wyoming 82071. Phone 307/ 766-3184.

   (NOTE: Film consists of scenes of tractors tipping and rolling. Each "accident" is analyzed as to whether it was caused by negligence, haste, or poor judgment.)

B. Provide students with objective sheet.

C. Provide students with information and job sheets.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

(NOTE: Limit study and discussion to the equipment available.)

F. Demonstrate and discuss procedures outlined in job sheets.

G. Provide alternate jobs if job sheets are not practical.

H. Arrange a field trip for students to observe mowing and digging operations.

I. Bring cutter bar, rotary, and flail mower blades to classroom for students to observe and handle.

J. Invite a resource person to talk to students about different types of mowing conditions and equipment.

K. Give test.

SUGGESTED ACTIVITIES

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Job sheets

      1. Job Sheet #1--Operate a Rotary Mower with PTO Drive

      2. Job Sheet #2--Operate a Hydraulic Rotary Mower

      3. Job Sheet #3--Repair a Rotary Mower Blade

      4. Job Sheet #4--Operate a Flail Mower

      5. Job Sheet #5--Reverse or Replace Flail Mower Knives

      6. Job Sheet #6--Adjust Cutter Bar on a Sickle Mower

      7. Job Sheet #7--Operate a Sickle Mower

      8. Job Sheet #8--Replace Sickle Knife Sections

      9. Job Sheet #9--Repair a Sickle Knife

      10. Job Sheet #10--Operate a Posthole Digger

   E. Test

   F. Answers to test

III. Unit references

   A. *Fundamentals of Service: Mowing and Spraying Equipment.* Moline, Illinois: Deere & Company, 1971.

   B. *Safe Tractor Operation and Daily Care.* Athens, Georgia: American Association for Vocational Instructional Materials, 1981.

   C. *Selecting and Maintaining Field Mowers.* Athens, Georgia: American Association for Agricultural Engineering and Vocational Agriculture, 1966.

TRACTOR ATTACHMENTS
UNIT X

INFORMATION SHEET

I. Terms and definitions

A. Auger--Rotating earth drill on a posthole digger

B. Backslope--Side of a ditch away from the road

C. Bevel--Two surfaces coming together at an angle other than 90 degrees (Figures I and 2)

EXAMPLE:

FIGURE 1

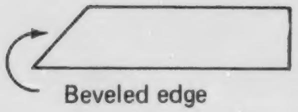
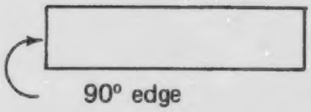


FIGURE 2



D. Cutter bar--Bar to which blades are attached on a sickle mower

E. Cutter bar lead--Outer end of bar as set ahead of inner end

F. Drive--Means for giving motion to a part

G. Feeler gauge--Tool for measuring thickness

H. Foliage--Leaves, flowers, and branches

I. Serrated--Notched or toothed on edge

J. Tilt--Angle of cutter bar in relation to ground

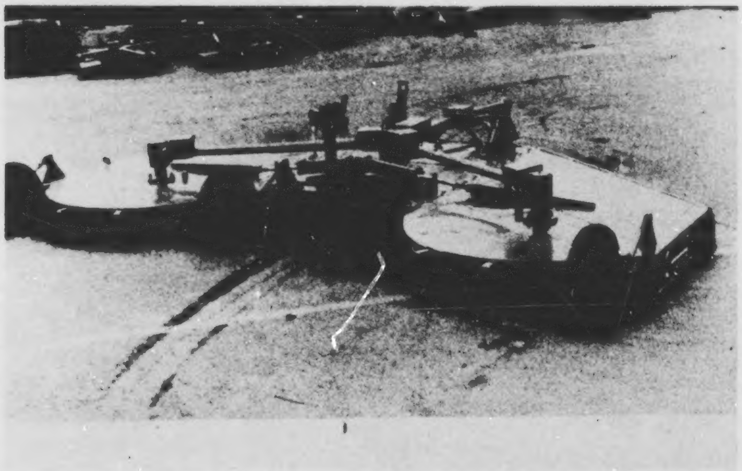
INFORMATION SHEET

II. Tractor attachments and parts (Figures 3-12)

A. Large (15 to 20 foot) rotary mower--Used on medians, slopes, and for production mowing

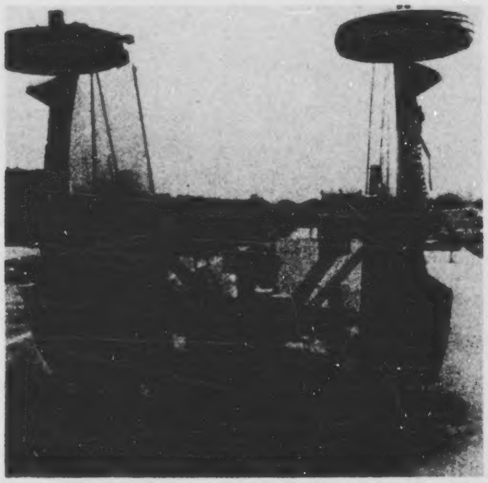
(NOTE: A 15-foot rotary mower can throw rocks and debris over 40 feet, causing injury and property damage.)

FIGURE 3 OPERATING POSITION



Courtesy of E.L. Caldwell & Sons, Inc.

FIGURE 4 TRAVEL POSITION

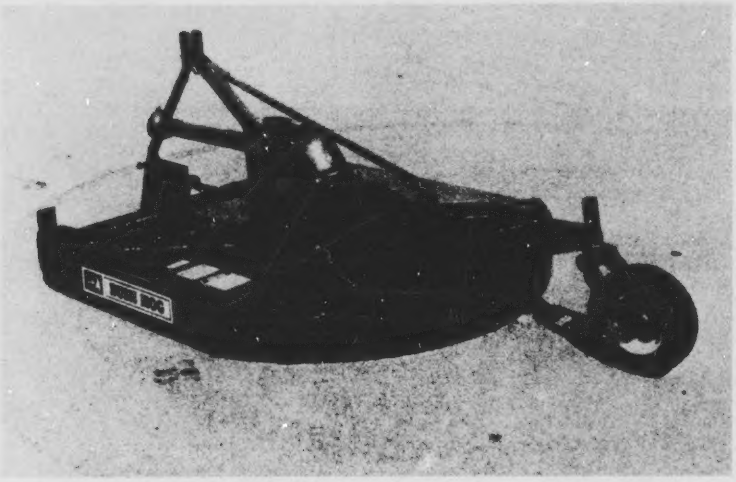


Courtesy of E.L. Caldwell & Sons, Inc.

INFORMATION SHEET

B. Small (5-foot) rotary mower--Used for mowing around guardrails, delineator posts, and bridge approaches

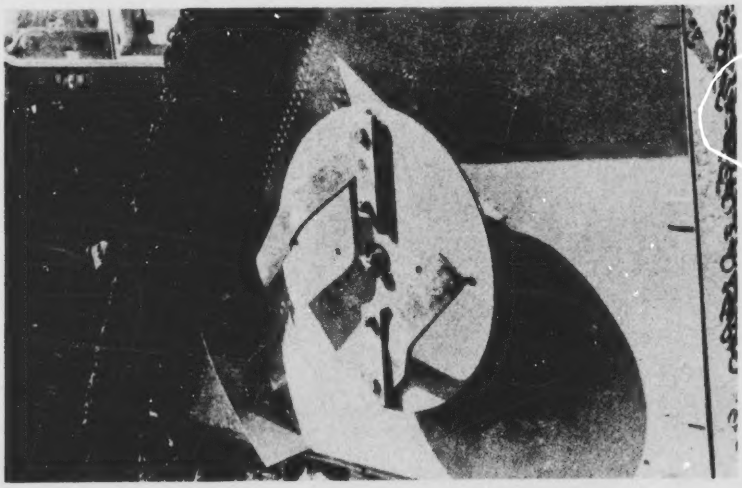
FIGURE 5



Courtesy of Bush Hog®, Allied Products Corporation.

C. Rotary mower blades

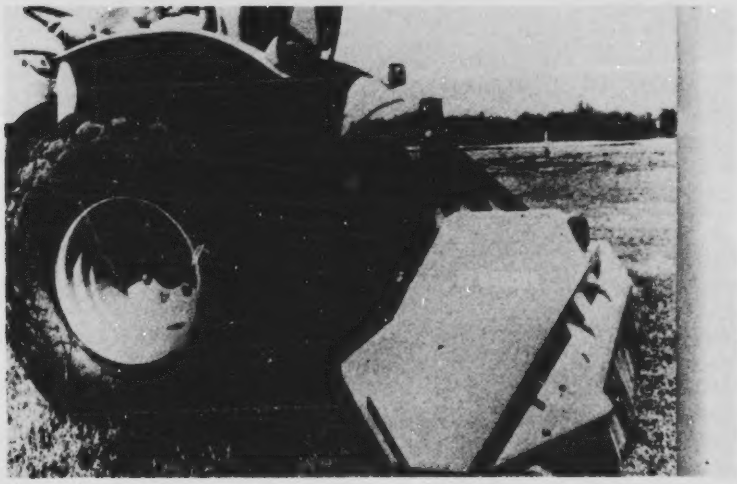
FIGURE 6



INFORMATION SHEET

D. Flail mower--Used for smaller mowing jobs in populated areas

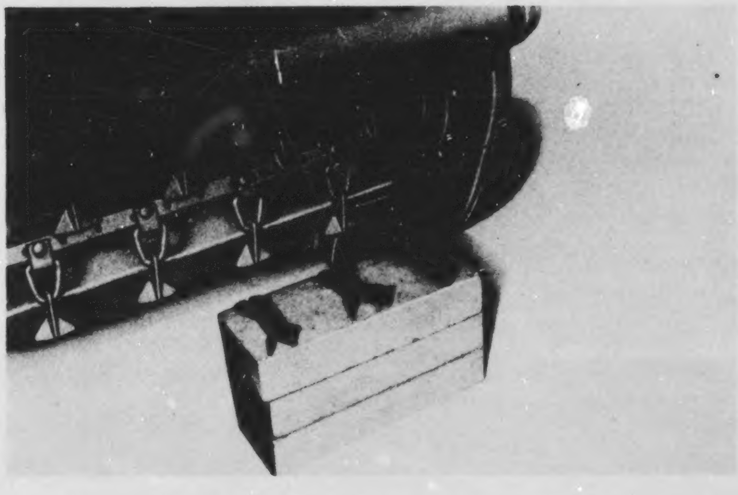
FIGURE 7



Courtesy of Kubota Tractor Corporation.

E. Flail mower blades

FIGURE 8

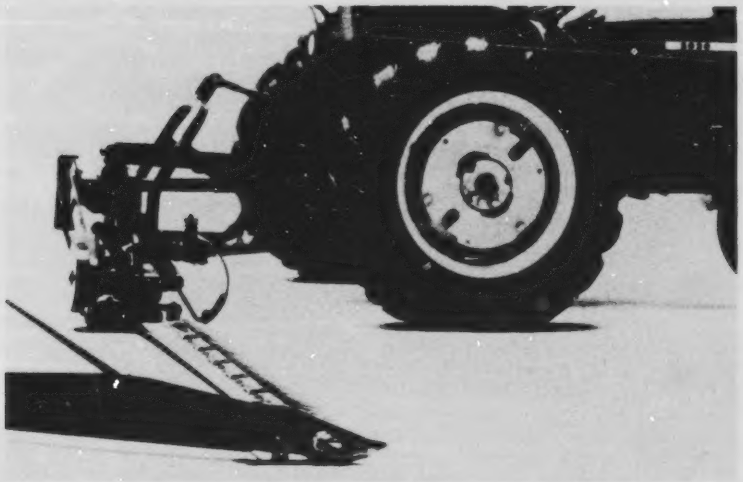


Courtesy of Ford Tractor Operations.

INFORMATION SHEET

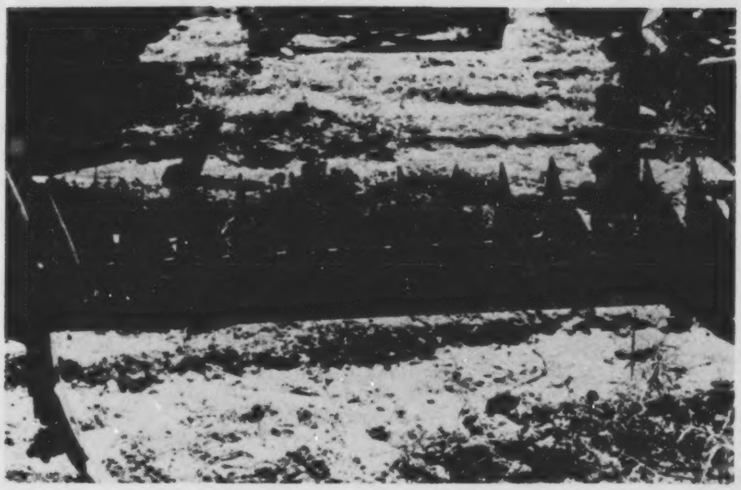
F. Sickle mower--Used for trimming, mowing steep slopes, and mowing around culvert heads

FIGURE 9



G. Sickle mower blades

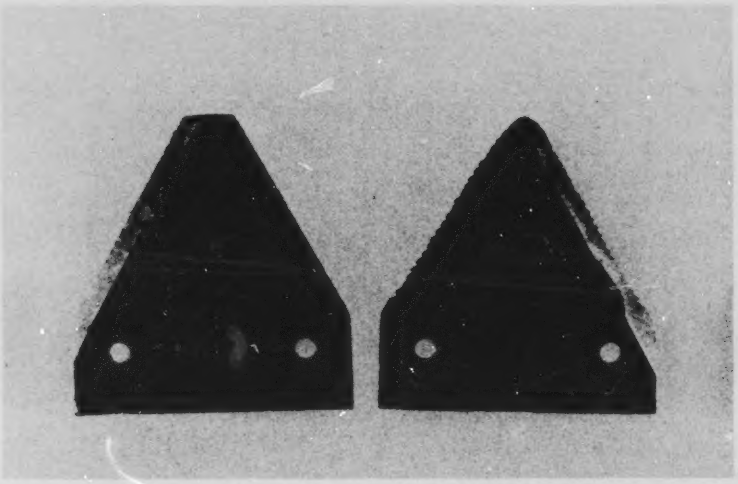
FIGURE 10 BLADE ASSEMBLY



INFORMATION SHEET

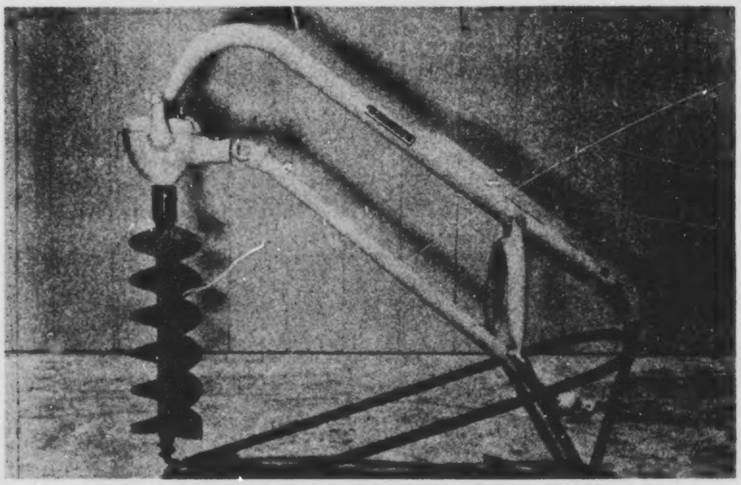
FIGURE 11

KNIVES



H. Posthole digger--Used to dig holes for signposts and guardrails

FIGURE 12



Courtesy of Danuser Machine Company.

INFORMATION SHEET

III. Safety rules for mowing

- A. Place warning signs at both ends of mowing area
- B. Mow with traffic
- C. Keep alert to traffic

  EXAMPLES: Pull out around culverts, turnarounds.
- D. Mow up and down the face of a steep slope

  (CAUTION: Never mow across a slope with a ratio greater than 3:1.)
- E. Mount and dismount with care

  EXAMPLES: Check ground for rocks and holes before dismounting; steps may be slippery.
- F. Shut down mower when any person or animal approaches

  (NOTE: Rotary and flail mowers will throw rocks and debris which can cause serious injury.)
- G. Work at a safe distance from spectators and other workers
- H. Never clean, oil, or adjust mower when it is running
- I. Always lower three-point hitch when shutting off tractor engine
- J. Be sure power shaft and master shields are in place
- K. Disengage PTO when mower is not in operation
- L. Disengage PTO before dismounting tractor

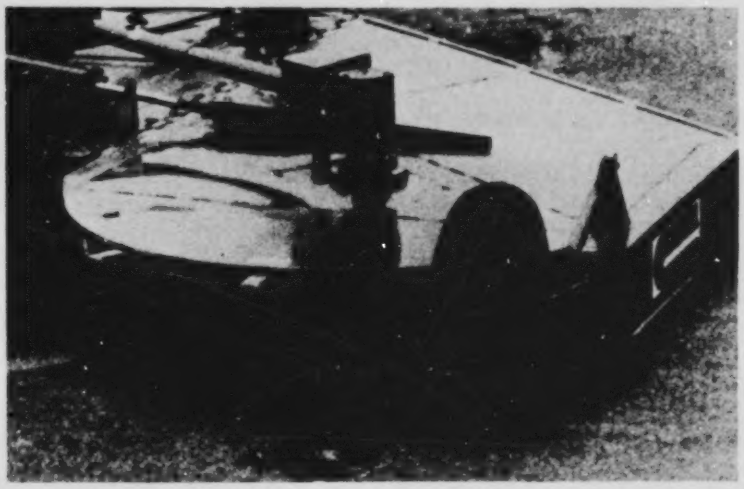
INFORMATION SHEET

M. Be sure all guard devices are in good working order

(NOTE: If guard plate is not properly installed, mower can throw rocks on the operator.)

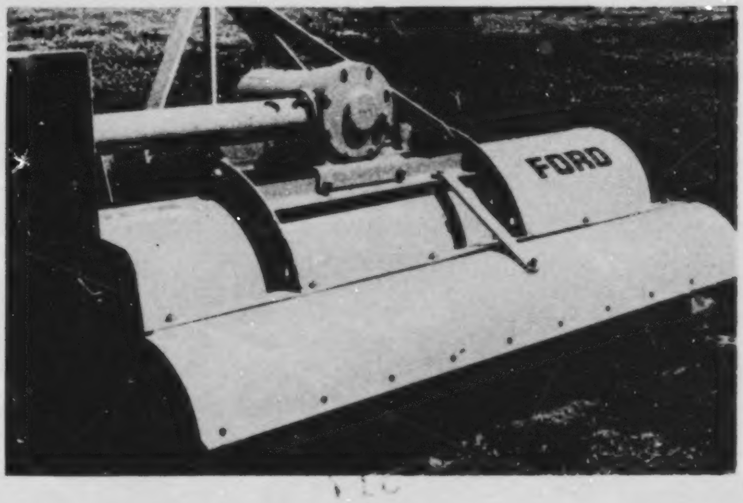
EXAMPLES: Rotary mower chain guard should be intact with no tangles (Figure 13); flail mower front guard plate should be in place with no holes (Figure 14).

FIGURE 13



Courtesy of E.L. Caldwell & Sons, Inc.

FIGURE 14



INFORMATION SHEET

IV. Techniques for effective mower operation

A. Operate mower at highest position that will give desired cutting results

B. Be sure all guards are secure and in good operating condition

C. Run the mower level under normal conditions

D. Tilt a rotary mower 2 or 3 inches lower in front for rough cutting conditions

E. Mow in direction that allows cut material to be thrown toward uncut area

(NOTE: On the next overlap, you will get an even distribution of material.)

F. Mow recommended swath; cross roadway and mow other side; return and make second pass

G. Check height of cut by turning one blade of rotary mower to front of mower, enabling you to see height of blade from ground

H. If blades dig into ground, disengage PTO and move tractor forward or backward until blades are clear

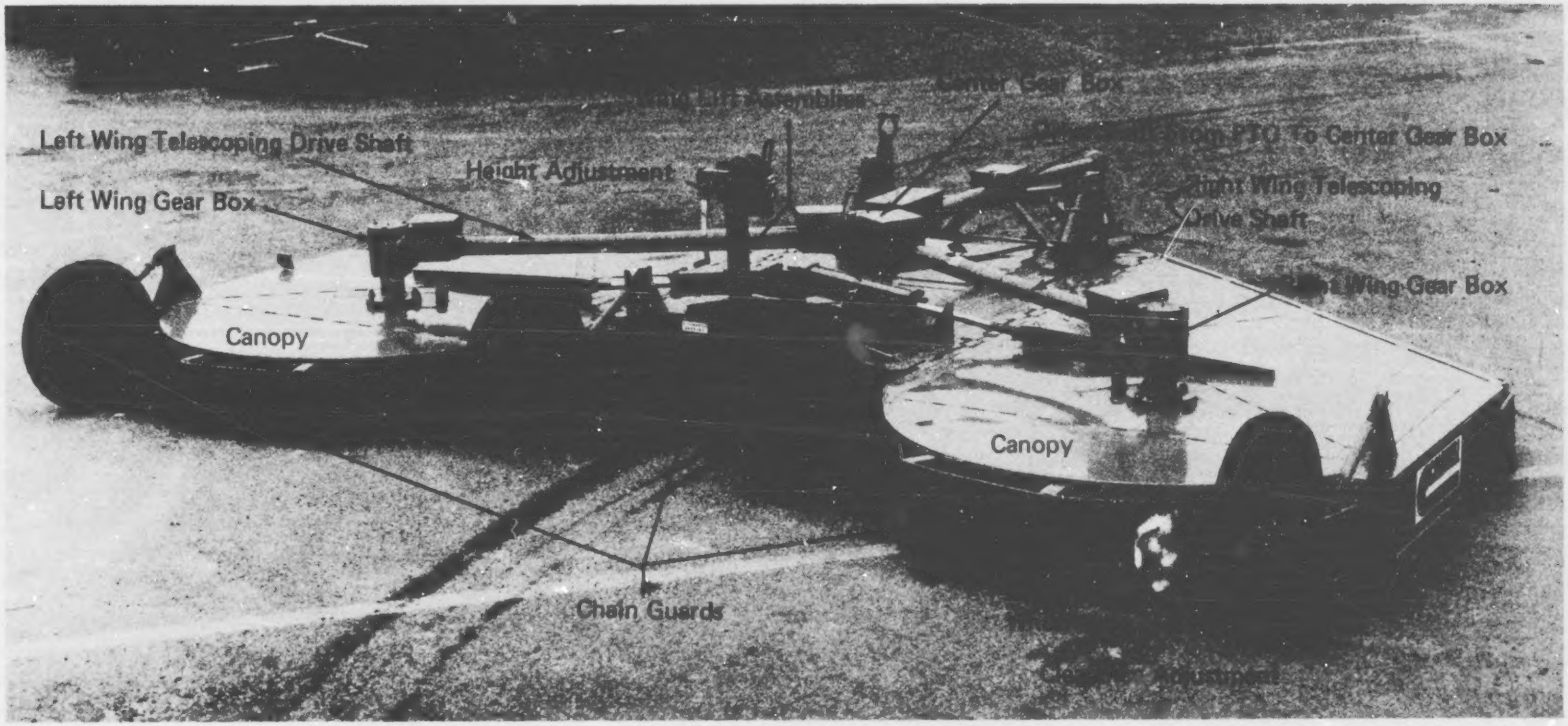
(NOTE: Do not free blades by increasing mower speed.)

INFORMATION SHEET

V. Parts of a rotary mower (Job Sheets #1 and #2; Figures 15 and 16)

A. PTO-driven rotary mower

FIGURE 15


Wing Lift Assemblies
Center Gear Box
From PTO To Center Gear Box
Left Wing Telescoping Drive Shaft
Height Adjustment
Right Wing Telescoping Drive Shaft
Left Wing Gear Box
Right Wing Gear Box
Canopy
Canopy
Chain Guards

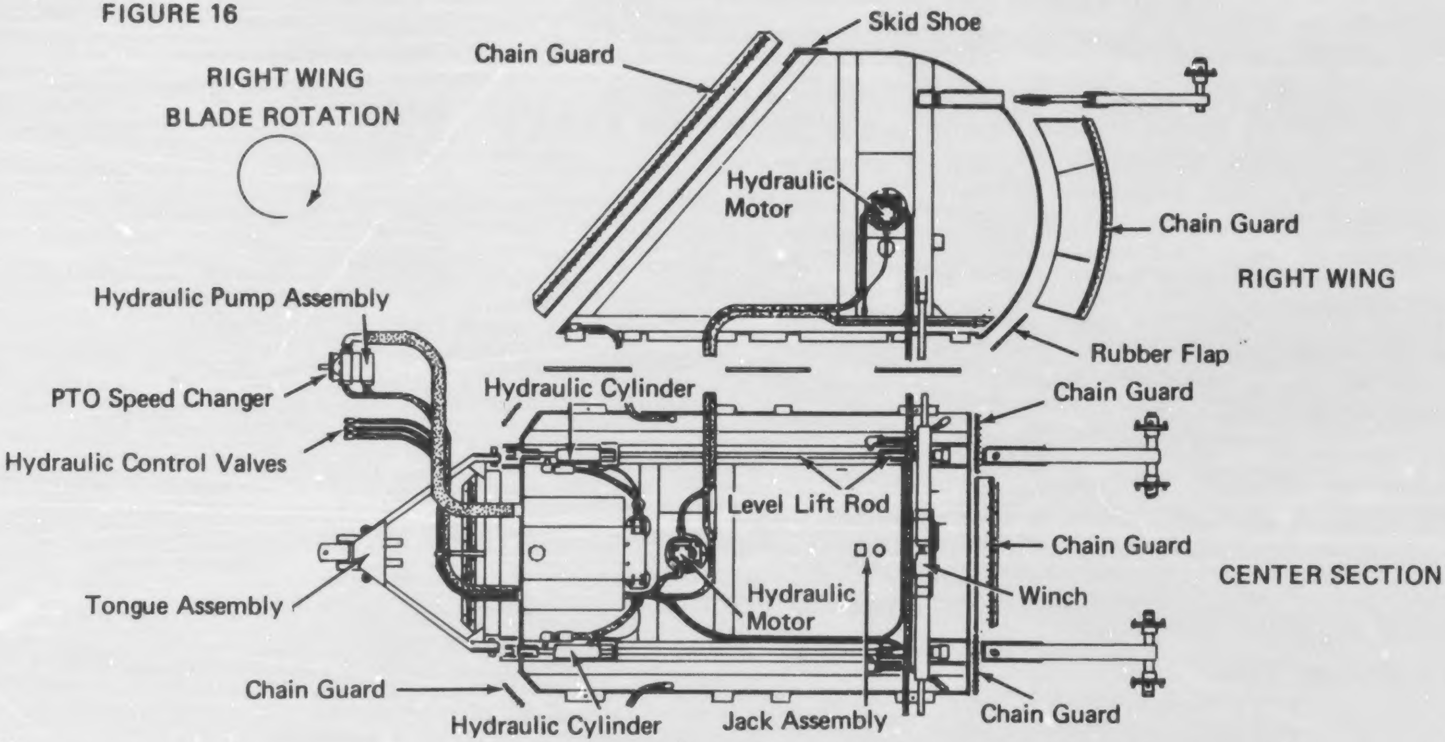
Used with permission of E.L. Caldwell and Sons, Inc.

INFORMATION SHEET

B. Hydraulic rotary mower

(NOTE: Diagram shows center and right wing section only. Left wing section has the same parts as right wing.)

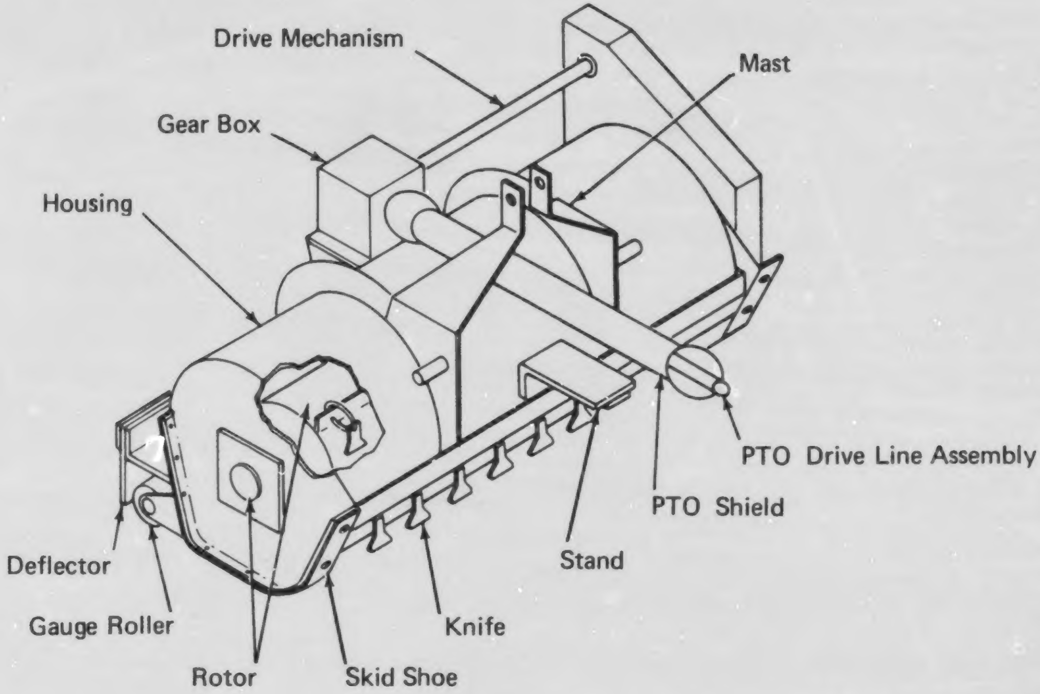
FIGURE 16


RIGHT WING
BLADE ROTATION
Chain Guard
Skid Shoe
Hydraulic Motor
Chain Guard
RIGHT WING
Rubber Flap
Hydraulic Pump Assembly
PTO Speed Changer
Hydraulic Control Valves
Hydraulic Cylinder
Chain Guard
Level Lift Rod
Chain Guard
CENTER SECTION
Tongue Assembly
Hydraulic Motor
Winch
Chain Guard
Hydraulic Cylinder
Jack Assembly
Chain Guard

Used with permission of Terrain King Corporation.

VI. Parts of a flail mower (Job Sheets #4 and #5; Figure 17)

FIGURE 17


Drive Mechanism
Mast
Gear Box
Housing
PTO Drive Line Assembly
PTO Shield
Stand
Deflector
Gauge Roller
Knife
Rotor
Skid Shoe

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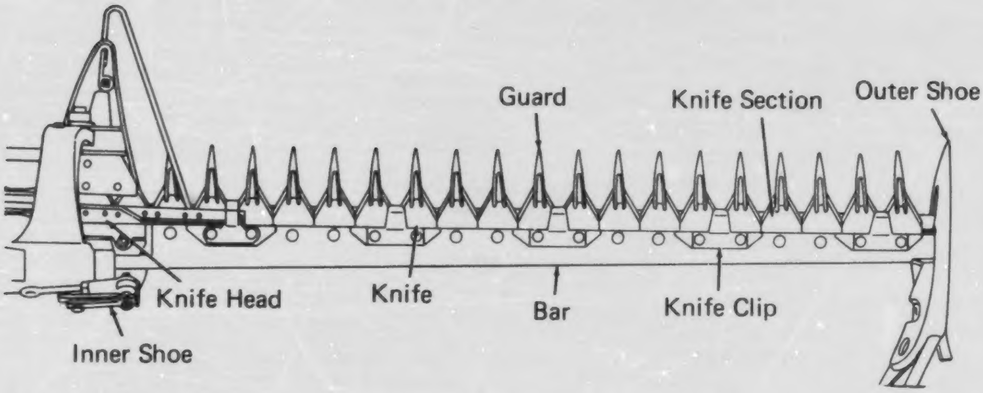
INFORMATION SHEET

VII. Parts of a cutter bar and their functions (Job Sheets #6-#9; Figure 18)

(NOTE: A cutter bar or sickle mower operates like hedge-trimming shears. The knife moves back and forth over guard surfaces, cutting with each stroke.)

EXAMPLE:

FIGURE 18


Guard
Knife Section
Outer Shoe
Knife Head
Knife
Bar
Knife Clip
Inner Shoe

Used with permission of Deere & Company, Moline, Illinois.

A. Inner and outer shoes--Gauging mechanisms that hold cutter bar off ground at desired cutting height

B. Knife head--Connecting point between knife and drive

C. Knife--Cutting blade

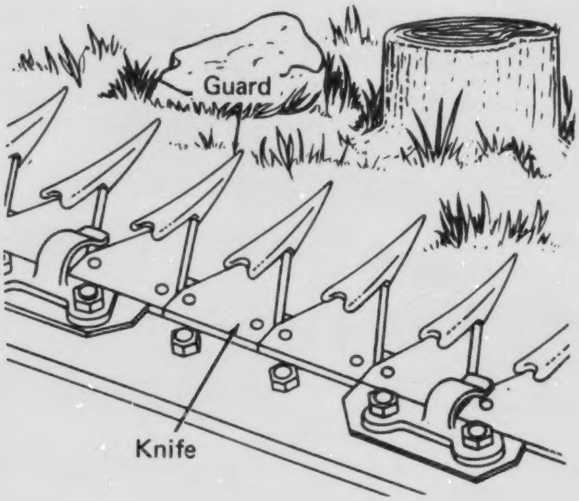
INFORMATION SHEET

D. Guard--Protects knife and acts as stationary shearing edge for moving section

(NOTE: Guards also divide plants and guide them into sections for easy cutting. See Figure 19.)

EXAMPLE:

FIGURE 19



Used with permission of Deere & Company, Moline, Illinois.

E. Knife section--Individual cutting unit

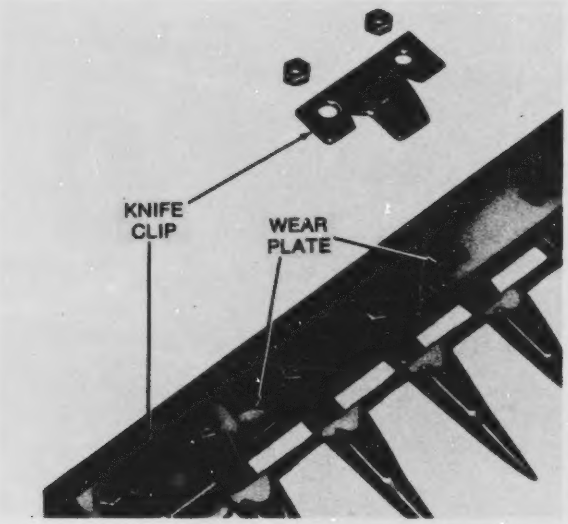
F. Bar--Supports knives, clips, and wear plates

INFORMATION SHEET

G. Knife clip--Holds knife snugly against ledger plates for clean cutting (Figure 20)

EXAMPLE:

FIGURE 20


KNIFE CLIP
WEAR PLATE

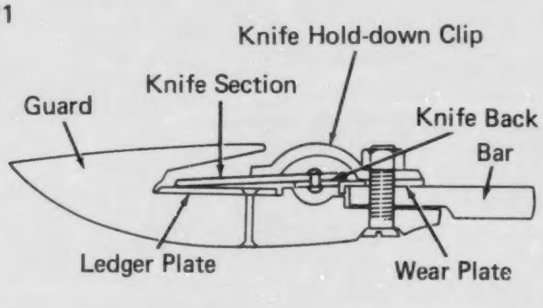
Courtesy of Deere and Company, Moline, Illinois.

H. Ledger plate--Cutting part of guard (Figure 21)

(NOTE: The plate can have either smooth or serrated edges. The ledger plate is secured to the guard either by riveting or by snapping plate into position.)

EXAMPLE:

FIGURE 21


Knife Hold-down Clip
Knife Section
Guard
Knife Back
Bar
Ledger Plate
Wear Plate

Used with permission of Deere & Company, Moline, Illinois.

I. Wear plate--Acts as guide for knife back, keeping it properly aligned with ledger plate so that shearing action can be maintained

INFORMATION SHEET

VIII. General procedures for mower maintenance

A. Know lubrication schedule

EXAMPLE: On a flail mower, universal slip joints and cutter shaft bearings need lubrication every eight hours of operation.

B. Make sure that all grease fittings are properly lubricated

C. Check that all hardware is tightened securely before each use

D. Keep blades sharp

E. Clear grass, chaff, or other matter from mower after each cutting operation

IX. Steps for sharpening mower blades (Job Sheets #3 and #9)

A. Wear safety goggles

B. Use oilstone, grindstone, or file

(NOTE: If an abrasive wheel must be used, grind only a small amount at a time, with tool rest no more than 1/8 inch from wheel. A file is less satisfactory because it is difficult to file to the proper angle.)

C. Check blade manual for angle

D. Hold tool *lightly* against wheel to prevent overheating

E. Dip blade frequently in water to cool

X. Components that need adjusting on a sickle mower cutter bar (Job Sheet #6)

(NOTE: Components A, B, and C must be adjusted before use; D-H are adjusted when servicing mower.)

A. Cutter bar lead

B. Operating height

C. Cutter bar tilt

D. Knife head guides

E. Wear plates

F. Hold-down clips

G. Guards

H. Guard lip clearance

INFORMATION SHEET

XI. Maintenance procedures for a sickle mower

  A. Keep knives clean

  B. Keep knives sharp

  C. Keep wear plates, knife hold-down clips, and knife-head guides in adjustment

  D. Maintain proper lead angle

  (NOTE: For a good knife cut, the entire length of the cutter bar must be at a right angle to forward direction of travel.)

  E. Service drive mechanisms at manufacturer's recommended intervals

XII. Safety precautions for operating a posthole digger (Job Sheet #10)

  A. Wear gloves and safety goggles or face shield during assembly, operation, installation, adjustment, or removal

  B. Wear close-fitting clothes

  C. Keep guards and safety shields in place during operation

  D. Do not operate PTO with tractor safety shield removed

  E. Shut off tractor engine, set brakes, and lower implement to the ground before leaving tractor seat

  F. Keep spectators clear of auger when in operation

  G. Do not oil or adjust auger while in operation

  H. Operate all PTO-powered augers at 540 rpm unless otherwise advised

  I. Do not attempt to operate auger on steep hillsides

  J. Reduce speed while driving over rough ground

  K. Use tools designed for the specific task you are performing

  L. Keep all bolts and nuts tight

  M. Replace any damaged or worn parts immediately

  EXAMPLES: Hydraulic hoses and fittings, bearings

  N. Use support jacks when operating auger in difficult soil conditions

  EXAMPLES: Hardpan or rocky soil will cause the auger to bounce; thick clay or mud will cause suction when removing auger from holes.

  O. Post warning signs at open holes

INFORMATION SHEET

XIII. Techniques for operating a posthole digger (Job Sheet #10)

(NOTE: The auger is mounted on a standard three-point hitch, and pivots on the support arms of the hitch. It is raised and lowered by remote hydraulic controls and rotated by tractor PTO. The auger can drill straight down when the tractor is headed either uphill or downhill. The side tilt can be adjusted with the right lift-leveling arm on the three-point hitch.)

(CAUTION: A rotating auger can throw dirt and rocks, and obstructions can upset the tractor. Use extreme caution when operating this attachment. DO NOT OVERSPEED THE AUGER.)

A. Run engine at slow speed until auger digs into ground and type and texture of soil is determined

B. Clear auger frequently after it has dug deep enough into ground to be loaded with dirt (about 1 foot)

(NOTE: Loose dirt is removed from hole by raising auger to dispel soil. This action of lowering and raising auger should be continued until hole reaches the desired depth.)

C. Take extra care to position auger shaft at proper angle on hillside or extremely uneven terrain

D. Use wheel chocks

XIV. Techniques for operating a posthole digger in difficult soil conditions

(NOTE: As a general rule, the greater the operating range of the digger drive assembly, the less force there is available for raising the auger in difficult soil conditions. Therefore, it is recommended that the three-point hitch be adjusted toward the minimum required operating range. Check operator's manual for specific instructions.)

A. Rocky soil--Use augers with sharp points and cutting blades

(NOTE: If rocks are large and place an obvious strain on the auger, raise the auger frequently. This will pull the rocks loose.)

B. Sticky soil or clay--Increase power, lower speed of auger and reverse auger rotation quickly to loosen material

C. Wet earth or mud--Provide a firm foundation for tractor; do not attempt to lift as much dirt as in normal operation

(CAUTION: Suction will be created and may cause tractor to upset.)

D. Frozen earth--Use augers with sharp points and cutting blades

TRACTOR ATTACHMENTS
UNIT X

JOB SHEET #1--OPERATE A ROTARY MOWER WITH PTO DRIVE

I. Equipment and materials

   A. Tractor with rotary mower attached

   B. Tractor operator's manual

   C. Mower operator's manual

   D. Recommended safety equipment

      1. Hard hat

      2. Close-fitting clothing

      3. Hard-toed shoes

      4. Earplugs

      5. Gloves

      6. Goggles

II. Procedure

   A. Read operator's manual

   B. Check PTO for 540 rpm stub shaft

   C. Complete daily maintenance and inspection

   D. Adjust cutting height

   (NOTE: Operate at highest position which will give desired cutting results according to plant and ground conditions.)

      1. Inspect blade level by moving blade to front of cutter; then measure level

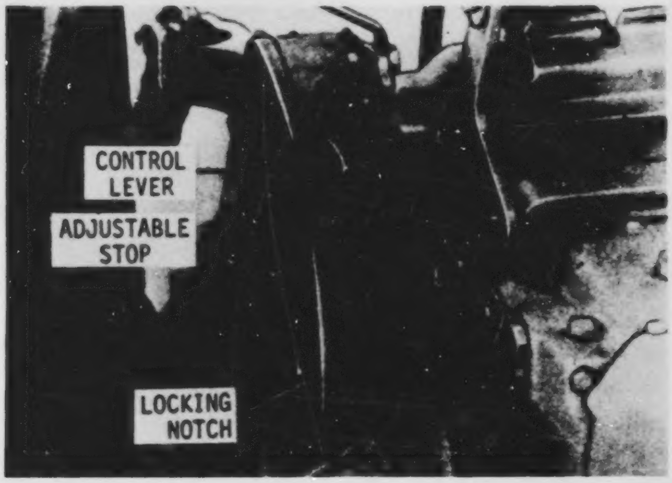
      (CAUTION: Be sure tractor is not running and PTO is disengaged before inspecting blades.)

      2. Check operator's manual for special height adjustment equipment

JOB SHEET #1

3. Raise or lower the three-point hitch with rockshaft control lever (Figure 22)

FIGURE 22

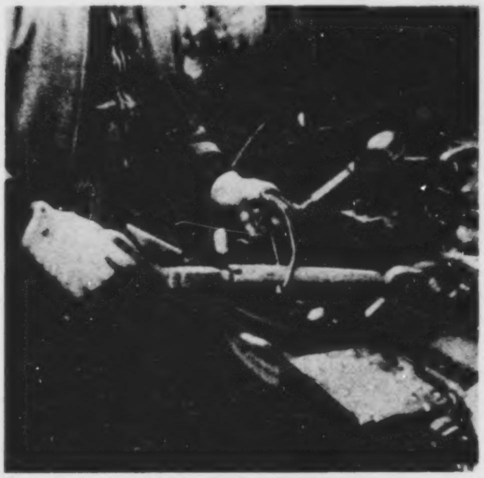

CONTROL LEVER
ADJUSTABLE STOP
LOCKING NOTCH

Courtesy of Deere & Company, Moline, Illinois.

4. Set the depth stop against rockshaft control lever according to tractor operator's manual

5. Adjust the center link on the three-point hitch to raise or lower rear of mower if needed (Figure 23)

FIGURE 23



Courtesy of Deere and Company, Moline, Illinois.

JOB SHEET #1

6. Level cutter from right to left with screw crank on right lift link of hitch

E. Post warning signs

F. Check area for obstacles

G. Start tractor engine

H. Engage PTO at idle speed

I. Briefly let mower run slowly, then accelerate

J. Mow a swath

K. Travel at a speed that will meet mowing conditions

L. Turn across roadway and mow a swath on opposite side

(NOTE: Use caution when crossing the roadway.)

M. Repeat alternating sides until job is completed

N. Disengage PTO

O. Stop tractor engine

P. Wait until all movement has stopped

Q. Dismount properly

TRACTOR ATTACHMENTS
UNIT X

JOB SHEET #2--OPERATE A HYDRAULIC ROTARY MOWER

I. Equipment and materials

- A. Tractor with hydraulic rotary mower attached
- B. Tractor operator's manual
- C. Mower operator's manual
- D. Toolbox
- E. Recommended safety equipment
    1. Hard hat
    2. Close-fitting clothing
    3. Hard-toed shoes
    4. Earplugs
    5. Gloves
    6. Goggles

II. Procedure

- A. Read and study operator's manual thoroughly
- B. Complete daily inspection and maintenance
- C. Check all control connections between tractor and mower
- D. Post traffic warning signs
- E. Mount tractor, using safety devices
- F. Start and warm up tractor engine

  (NOTE: Sit in operator's seat. Never start or operate tractor from any other position.)
- G. Release emergency brake
- H. Position tractor and mower where work is to begin
- I. Set emergency brake
- J. Put shift lever into neutral; reduce engine rpm

JOB SHEET #2

K. Engage PTO to hydraulic pump

L. Lower side wings to cutting position

M. Disengage PTO; dismount and set blades to desired cutting height if needed

(NOTE: Refer to operator's manual for procedure for setting cutting height.)

N. Mount tractor, sit in operator's seat, and fasten seat belt

O. Engage PTO at idle speed

P. Engage levers to hydraulic motors which rotate the blades

Q. After a few rotations of blades, accelerate and start mowing at a safe speed

(CAUTION: Be sure area is clear of personnel, animals, and obstructions before mowing.)

R. Mow a swath to end of programmed distance

S. Stop tractor and set parking brake

T. Disengage levers to hydraulic motors

U. Raise mower

V. Release emergency brake, turn across roadway, and position mower for next pass

W. Lower mower, and engage hydraulic motor to rotate blades

X. Mow a swath the same distance as the first pass

Y. Repeat above procedure and mow alternating sides until job is completed

Z. Disengage levers to hydraulic motors

AA. Park mowing equipment off roadway in a safe and fairly level location

BB. Raise side wings to 90-degree position

CC. Disengage PTO

DD. Shut down tractor engine

EE. Unfasten seat belt and dismount properly

FF. Secure side wings in raised position with chains or threaded rod with nuts

JOB SHEET #2

GG. Inspect equipment visually, list any defects, and report them to the proper authority

TRACTOR ATTACHMENTS
UNIT X

JOB SHEET #3--REPAIR A ROTARY MOWER BLADE

I. Equipment and materials

A. Tractor with rotary mower

B. Safety supports

C. Box or open-end wrenches

D. Bench grinder

E. Dressing tool

F. Recommended safety equipment

1. Hard hat
2. Close-fitting clothing
3. Hard-toed shoes
4. Earplugs
5. Gloves
6. Goggles

II. Procedure

A. Disengage PTO

B. Turn tractor ignition switch to OFF

C. Raise mower, using remote hydraulic lever

D. Place safety supports under base; secure wings with safety bar or chains

(CAUTION: Do not trust hydraulic system to support wings. Avoid walking under raised wings; use caution.)

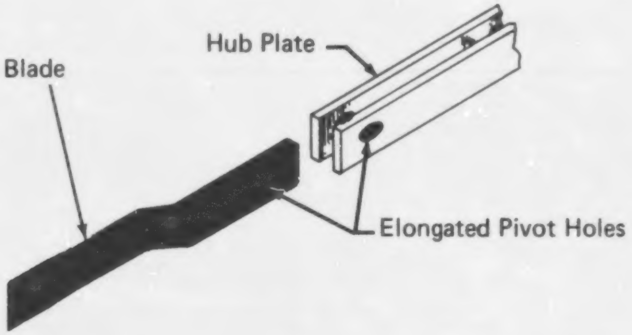
E. Check for bent, nicked, broken, or excessively worn knives

JOB SHEET #3

F. Check for excessive wear and elongation of pivot holes (Figure 24)

(NOTE: Pivot holes become enlarged or elongated with wear.)

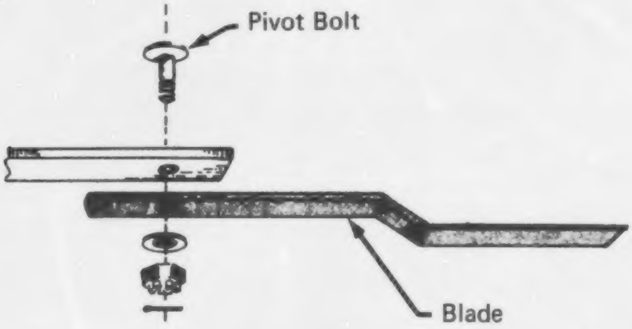
FIGURE 24



Used with permission of the American Association for Agricultural Engineering and Vocational Agriculture.

G. Remove blade (Figure 25)

FIGURE 25



Used with permission of the American Association for Agricultural Engineering and Vocational Agriculture.

H. Grind blade

(CAUTION: Wear safety goggles. See that guard is over wheel, and do not stand directly in line with the wheel.)

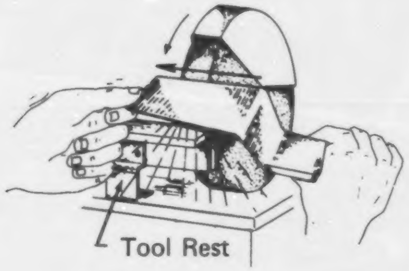
1. Dress and true grinding wheel

2. Hold beveled edge of blade lightly against grinding wheel face

JOB SHEET #3

3. Hold sharp edge up so that wheel turns *toward* it to prevent formation of a wire edge (Figure 26)

FIGURE 26



Used with permission of the American Association for Agricultural Engineering and Vocational Agriculture.

4. Move blade in one direction only, either to right or left
5. Follow original angle of cut
6. Remove same amount of metal from each knife blade to prevent unbalanced rotation
7. Check work after each stroke
8. Cool blade in water frequently to prevent overheating

I. Replace blade

J. Remove safety supports and release safety bar or chains

(CAUTION: Do not trust hydraulic system to support wing. Avoid walking under raised wings; use caution.)

K. Lower mower

TRACTOR ATTACHMENTS
UNIT X

JOB SHEET #4--OPERATE A FLAIL MOWER

I. Equipment and materials

    A. Tractor with flail mower attached

    B. Recommended safety equipment

        1. Hard hat

        2. Close-fitting clothing

        3. Hard-toed shoes

        4. Earplugs

        5. Gloves

        6. Goggles

    C. Tractor operator's manual

    D. Mower operator's manual

II. Procedure

    A. Read operator's manual

    B. Check PTO for 540 rpm stub shaft

    C. Complete daily maintenance and inspection

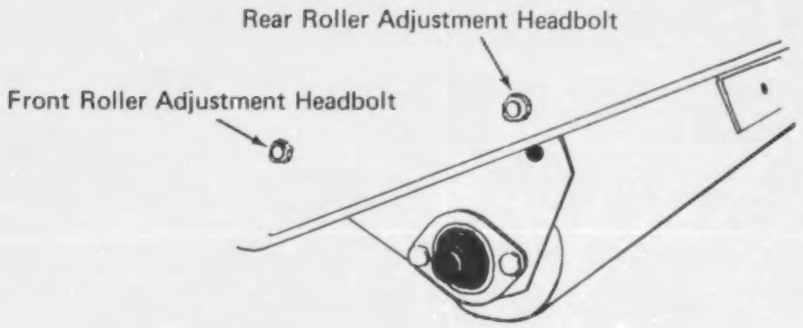
    D. Adjust cutting height

    (NOTE: See manufacturer's recommendations. Adjustment is made by removing bolts from roller brackets, moving roller to desired position, and replacing bolts.)

        1. Loosen *front* roller adjustment head bolts and lock nuts on both sides

2. Remove *rear* roller adjustment head bolts, flat washers, and lock nuts on both sides (Figure 27)

FIGURE 27


Rear Roller Adjustment Headbolt
Front Roller Adjustment Headbolt

3. Use tractor three-point hitch system to raise mower until desired cutting height is reached

   (CAUTION: Shut off tractor before proceeding.)

4. Secure roller by replacing bolts, flat washers, and nuts in desired adjustment holes

5. Tighten all bolts and nuts securely

E. Clear work area of objects which might be picked up and thrown by mower

F. Post warning signs

G. Mount tractor properly

H. Start tractor engine

I. Engage PTO at idle speed; accelerate slowly

(CAUTION: Do not start PTO at high speed.)

(NOTE: Start mower in clear area, not in cut.)

J. Allow cutter shaft to reach full speed

K. Mow designated area, alternating sides of road and turning with traffic

L. Shut off PTO

JOB SHEET #4

M. Shut off tractor engine

N. Dismount properly

O. Clear mower of debris, cuttings, or other materials

TRACTOR ATTACHMENTS
UNIT X

JOB SHEET #5--REVERSE OR REPLACE FLAIL MOWER KNIVES

I. Equipment and materials

A. Flail mower

B. Mower operator's manual

C. Jack

D. Safety supports

E. Gloves

F. Box or open-end wrenches (or special tools for type of knife support)

II. Procedure

(NOTE: Wear gloves when working around or handling blades.)

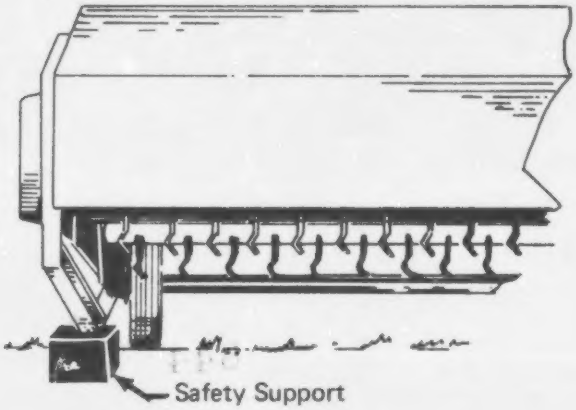
A. Disengage PTO

B. Turn tractor ignition switch to OFF

C. Raise mower with jack

D. Place safety supports under frame at each end (Figure 28)

FIGURE 28



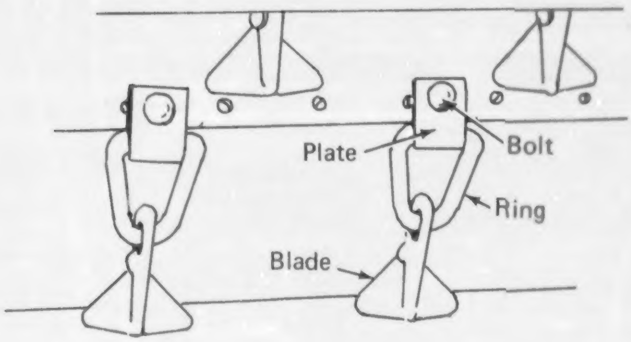
Used with permission of the American Association for Agricultural Engineering and Vocational Agriculture.

JOB SHEET #5

E. Check for bent, nicked, broken, or excessively worn knives

F. Remove bolt by loosening nut underneath (Figure 29)

FIGURE 29



Courtesy of Ford Tractor Operations.

G. Slip ring off plate

H. Remove blade from ring

I. Slip new blade onto ring with cutting edge to outside

(NOTE: On reversible blades, turn the blade around if cutting edges are in good condition.)

J. Replace ring in bracket

K. Insert bolt and tighten nut

L. Remove safety supports

M. Lower mower to ground

TRACTOR ATTACHMENTS
UNIT X

JOB SHEET #6--ADJUST CUTTER BAR ON A SICKLE MOWER

I. Equipment and materials

- A. Tractor with sickle mower attached
- B. Mower operator's manual
- C. Shims
- D. Feeler gauge
- E. Box or open-end wrenches
- F. Two ball peen hammers, one heavy and one lightweight
- G. Ruler
- H. Punch
- I. Cold chisel
- J. Tape measure
- K. 2-by-4-inch board approximately 6 feet long (or line for determining alignment)
- L. Ruler or straightedge
- M. Safety equipment
  - 1. Hard hat
  - 2. Close-fitting clothing
  - 3. Gloves
  - 4. Goggles

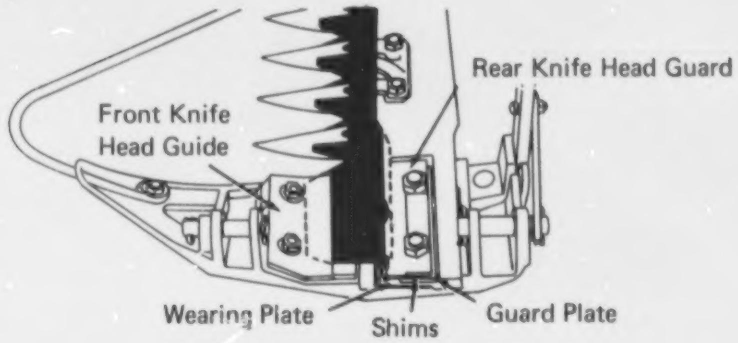
II. Procedure

- A. Adjust knife head guides
  - 1. Grasp knife head; move it up and down and from side to side
  - 2. If there is an unusual amount of play, adjust by adding or subtracting shims

JOB SHEET #6

3. Check operator's manual for correct vertical clearance
4. Insert feeler gauge for accurate spacing
5. Remove shims if too much clearance exists (Figure 30)

FIGURE 30


Rear Knife Head Guard
Front Knife Head Guide
Wearing Plate
Shims
Guard Plate

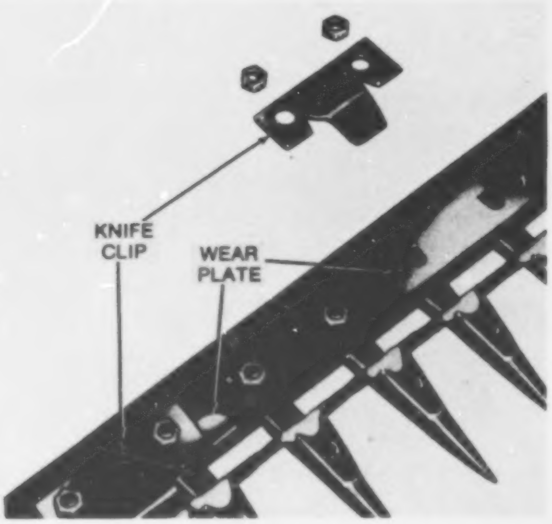
Used with permission of Deere & Company, Moline, Illinois.

B. Adjust wear plates (Figure 31)

1. Check condition of wear plates for excessive play
2. Move wear plates forward along slotted holes as needed

(NOTE: Do not adjust the wear plate too close.)

FIGURE 31


KNIFE CLIP
WEAR PLATE

Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #6

C. Adjust hold-down clips

(NOTE: If the hold-down clip holds the knife too loosely, ragged cutting and choking will result. If it is too tight, the knife will bind.)

1. Check manual for knife tilt

   (NOTE: Some manufacturers recommend that the knife lie flat on ledger plate; some recommend a 1/32 inch clearance between rear of ledger plate and rear of the knife section.)

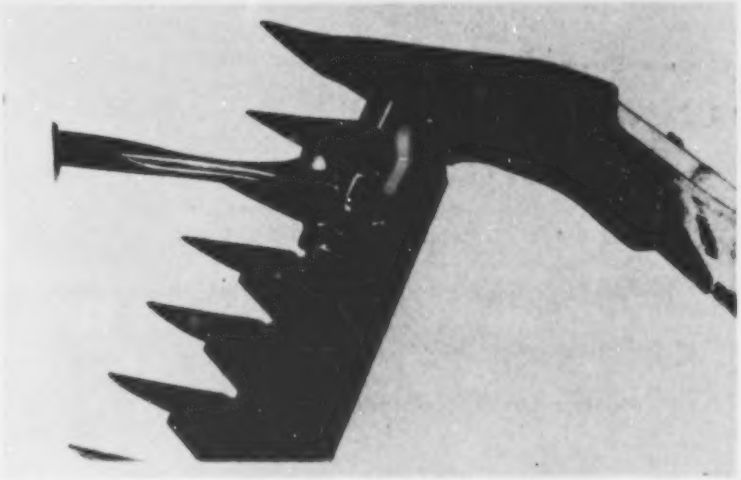
2. Put on safety goggles

3. Increase or reduce clearance

   a. Add or remove spacers to increase or reduce clearance between clip and knife section if clip is so equipped, OR

   b. Reduce clearance by striking top of clip with a lightweight hammer to bend it forward (Figure 32)

FIGURE 32

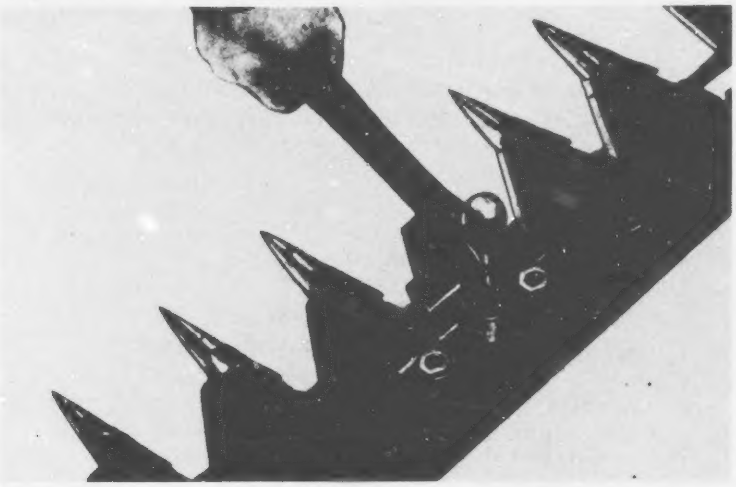


Courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #6

c. Increase clearance by striking flat surface at rear of clip (Figure 33)

FIGURE 33



Courtesy of Deere & Company, Moline, Illinois.

D. Adjust guards

1. Check each guard for wear, nicks, breakage, rust, and bending

    a. Use a file to remove rust and nicks and to sharpen guard points

    (NOTE: If guards cannot be sharpened, replace them.)

    b. Tighten ledger plates

    c. Replace any dull or broken ledger plates

2. Align guards

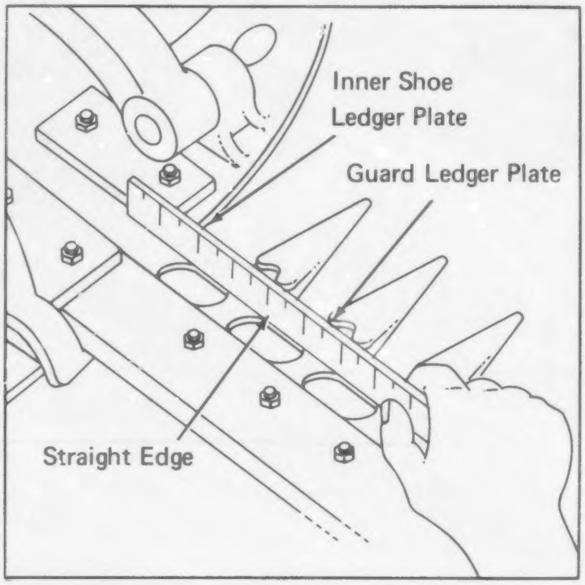
    (NOTE: Check for any guards that are too high, but do not adjust the majority of the guards upward to align with a few that are too high.)

    a. Check that cutter bar is held rigid by inner shoe and drive unit

JOB SHEET #6

b. Using a straightedge, line up first guard with inner shoe ledger plate (Figure 34)

FIGURE 34


Inner Shoe
Ledger Plate
Guard Ledger Plate
Straight Edge

Used with permission of Deere & Company, Moline, Illinois.

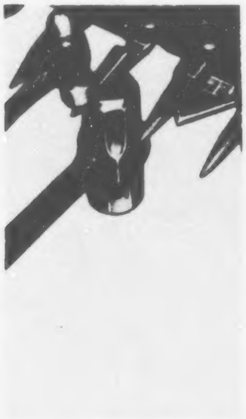
3. Straighten; realign with hammer and smooth with file
4. Check for nicks, bends, or dullness
5. Raise guard if needed by bending it up with a hammer

(NOTE: Strike guard in thickest area, usually just ahead of the ledger plate. Disregard position of the guard points; guard ledger plates must be in line.)

JOB SHEET #6

6. Lower guard, if needed, by holding heavy hammer under base of guard and pounding front of ledger plate (Figures 35 and 36)

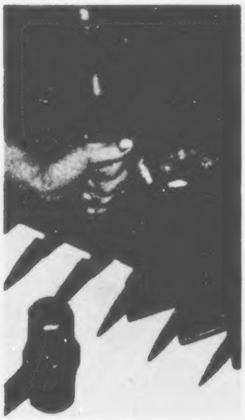
FIGURE 35



Setting Guard Down

Courtesy of Deere & Company, Moline, IL.

FIGURE 36



Setting Guard Up

Courtesy of Deere & Company, Moline, IL.

7. Perform the same procedure at outer shoe

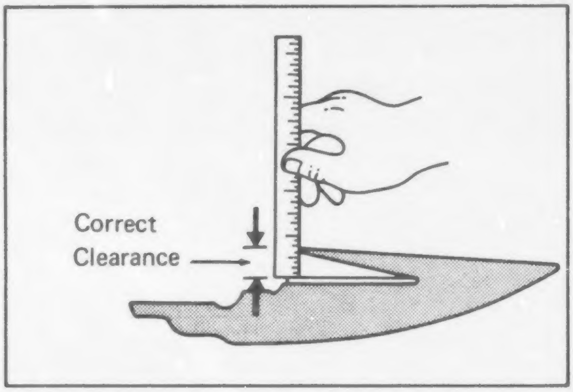
8. Sight down cutter bar and bend any other guards which are out of alignment

E. Adjust guard lip clearance

(NOTE: Always adjust guard lip clearance as last step in guard maintenance. Sometimes alignment will change the clearance.)

1. Measure clearance with ruler (Figure 37)

FIGURE 37



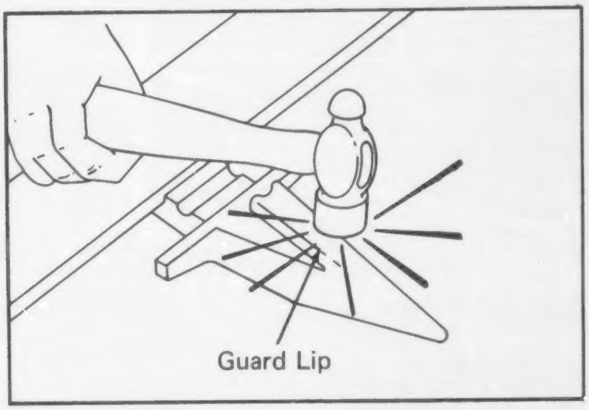
Used with permission of Deere & Company, Moline, Illinois.

JOB SHEET #6

2. Set clearance between 3/8 and 1/2 inch

   a. To decrease clearance, tap lightly on lip with a hammer (Figure 38)

FIGURE 38

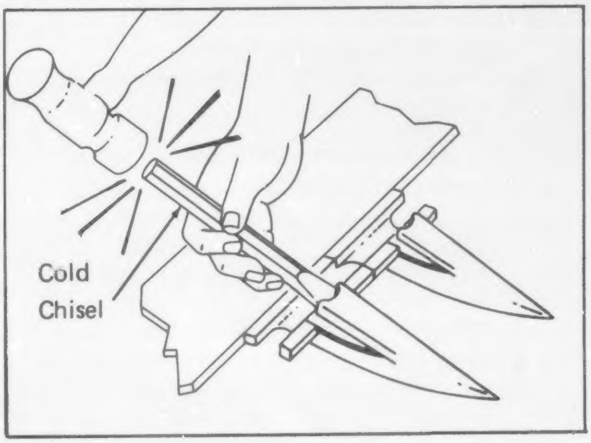


Used with permission of Deere & Company, Moline, Illinois.

   b. To increase clearance, use a chisel as a wedge; tap lightly (Figure 39)

   (CAUTION: Overbending can break the guard lip.)

FIGURE 39



Used with permission of Deere & Company, Moline, Illinois.

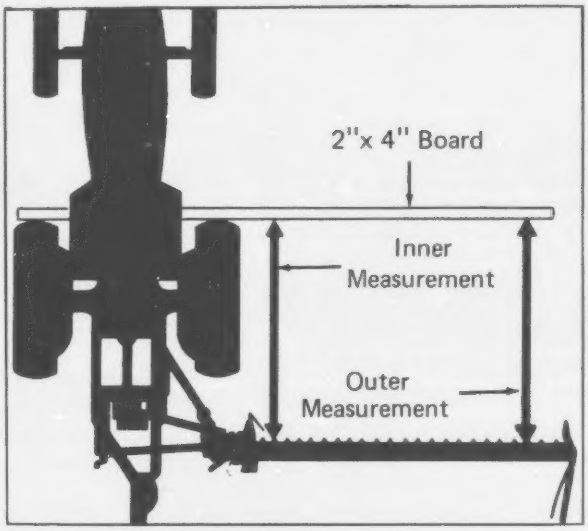
JOB SHEET #6

F. Adjust cutter bar lead

(NOTE: When mowing, the pressure of plants against cutter bar pushes the outer end backward until the cutter bar is at right angles to the forward motion. When mower is not in operation, the bar is set so that the outer end is ahead of the inner end to allow for this pressure.)

1. Place tractor and mower on level surface
2. Be sure cutter bar is flat on ground
3. Pull outer end of cutter bar backward by hand to take up any slack
4. Place a 2-by-4-inch straight board or a line in front of rear tires (Figure 40)

FIGURE 40



Used with permission of Deere & Company, Moline, Illinois.

5. Measure from board guideline back to knife section rivets

   (NOTE: Distance from outer end of cutter bar to board should be shorter than distance from inner end to board.)

6. Allow 1/4 inch per foot of cutter bar difference
7. Adjust lead according to operator's manual

JOB SHEET #6

G. Adjust operating height (Figures 41 and 42)

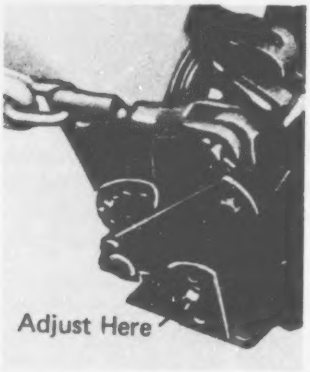
(NOTE: Height adjustment depends on type of growth or ground cover and on ground conditions. In stony conditions, a longer length of cut would be best to reduce cutter bar damage. If the ground is smooth and free of rocks, a shorter length of cut is possible. For trimming behind a rotary mower, a short length of cut is best.)

1. Remove bolts on inner shoe
2. Relocate bolts to desired position

   (NOTE: Be sure both ends are the same height.)

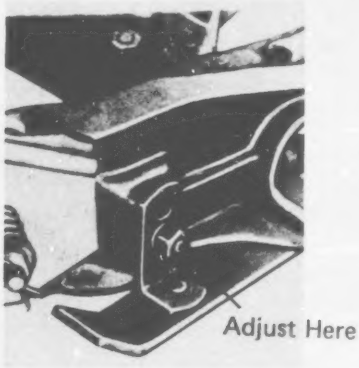
3. Tighten bolts
4. Repeat process on outer shoe

FIGURE 41 INNER SHOE



Courtesy of Deere & Company, Moline, IL.

FIGURE 42 OUTER SHOE



Courtesy of Deere & Company, Moline, IL.

H. Adjust cutter bar tilt

(NOTE: Correct tilt is the basis of a good mowing job. If the ground is covered with dead grass, stubble, or tangled weeds, use a downward angle to lift the grass. If mowing in a stony area, tilt blade upward to avoid damaging blades.)

I. Set tilt according to operator's manual

TRACTOR ATTACHMENTS
UNIT X

JOB SHEET #7--OPERATE A SICKLE MOWER

I. Equipment and materials

  A. Tractor with sickle mower attached

  B. Tractor operator's manual

  C. Mower operator's manual

  D. Recommended safety equipment

    1. Hard hat

    2. Close-fitting clothing

    3. Hard-toed shoes

    4. Earplugs

    5. Gloves

    6. Goggles

  E. Warning signs

II. Procedure

  A. Read operator's manual

  B. Check PTO for 540 rpm stub shaft

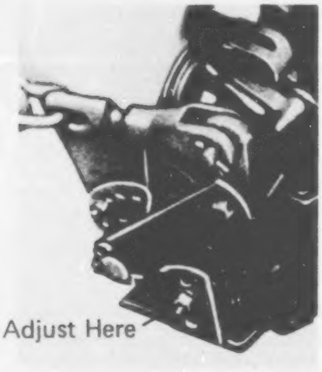
  C. Complete daily maintenance and inspection

JOB SHEET #7

D. Adjust cutting height (Figures 43 and 44)

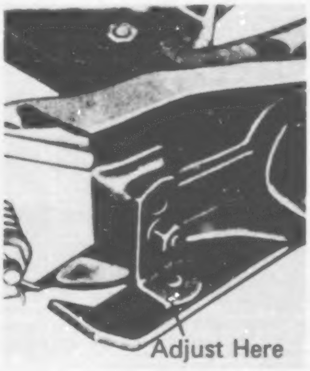
1. Remove bolts in inner and outer shoes
2. Relocate bolts to desired position
3. Tighten bolts

FIGURE 43 INNER SHOE



Courtesy of Deere & Company, Moline, IL.

FIGURE 44 OUTER SHOE



Courtesy of Deere and Company, Moline, IL.

E. Check area for obstacles

F. Post traffic warning signs

G. Mount tractor properly

H. Lower cutter bar

I. Start tractor engine

J. Engage PTO at idle speed

K. Let mower run slowly while observing knife and other moving parts to see that they operate freely

L. Allow tractor to reach rated PTO speed

M. Begin mowing

N. Travel at a speed that will meet mowing conditions

EXAMPLES: Travel 3 to 7 mph in thick growth or foliage; faster in short, thin growth

JOB SHEET #7

O. Make a turn

(NOTE: Sickle mowers will cut neat, square corners. It is seldom necessary to raise the cutter bar at corners.)

1. Turn quickly when near end of cut
2. Use right brake to assist right turn

   (NOTE: On right turn, tractor should pivot on right rear wheel.)

3. Turn at slower speed when making left turn

   (NOTE: The cutter bar swings around faster when turning to the left and increases the possibility of striking an unnoticed obstacle.)

P. Cross roadway and mow in the opposite direction

Q. Repeat crossing and mowing until you have completed required number of passes on each side of roadway

R. Raise cutter bar and secure it according to manufacturer's recommendations

S. Disengage PTO

T. Stop tractor engine

(CAUTION: Be sure PTO is disengaged and tractor engine is off before handling cutter bar.)

U. Wait until all movement has stopped

V. Dismount properly

TRACTOR ATTACHMENTS
UNIT X

JOB SHEET #8--REPLACE SICKLE KNIFE SECTIONS

I. Equipment and materials

- A. Cutter bar
- B. Mower operator's manual
- C. Wooden blocks
- D. Pump-type oil can and oil
- E. Box or open wrenches
- F. Vise
- G. Ball peen hammer
- H. Rivet-setting tool
- I. Replacement rivets
- J. Replacement knife sections
- K. Cold chisel
- L. Pin punch
- M. Section clamp
- N. Recommended safety equipment
  1. Hard hat
  2. Close-fitting clothing
  3. Hard-toed shoes
  4. Gloves
  5. Goggles

JOB SHEET #8

II. Replacing sections with knife removed from cutter bar

A. Remove knife from cutter bar

(CAUTION: Be extremely careful. Wear gloves to protect hands.)

1. Oil knife

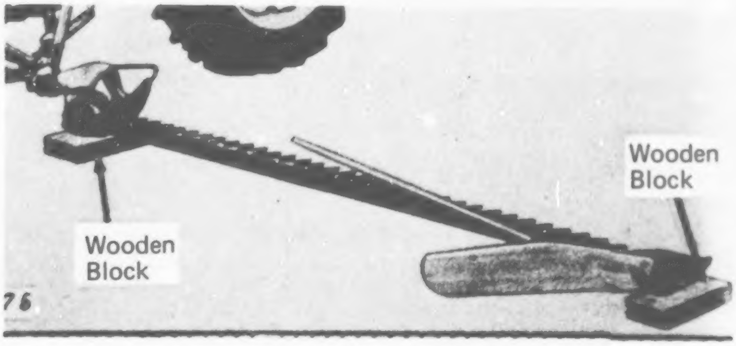
2. Turn on engine and run knife back and forth for a minute to loosen any rust deposits

   (NOTE: If the knife is gummed up, spray water over the knife while it is running.)

3. Turn off engine

4. Block up cutter bar with wooden blocks (Figure 45)

FIGURE 45



Courtesy of Deere & Company, Moline, Illinois.

5. Remove connector from knife head according to manufacturer's recommendations

6. Using both hands, grasp knife on its back side away from knife sections

   (CAUTION: If the sections hang up on the ledger plates, maneuver them with a wooden block, not your fingers.)

B. Place first section in vise with knife tips down and knife back resting on stationary jaw of vise

C. Set vise grip loosely so that section can be driven between jaws

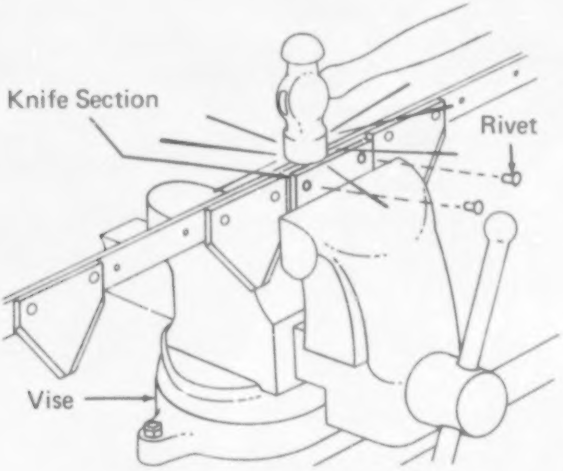
JOB SHEET #8

D. Shear rivets off by hitting the section with a ball peen hammer (Figure 46)

(CAUTION: Flying rivets are extremely dangerous.)

(NOTE: Shear heads off; *do not* punch head through, or you will enlarge the holes in the knife back.)

FIGURE 46



Used with permission of Deere & Company, Moline, Illinois.

E. Punch rivet stems out with pin punch

F. Loosen vise and remove knife section

(CAUTION: Blades may be sharp enough to cut. Handle carefully.)

G. Repeat steps B-F, removing every other section

H. Remove knife from vise

I. Place knife on riveting block with beveled side of sections up

J. Set a new section in place, lining up holes

K. Select correct rivet size

(NOTE: A rivet should extend 1 1/2 to 2 times its diameter through knife section.)

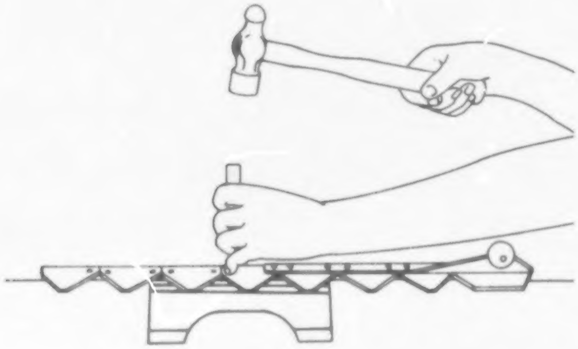
L. Insert two rivets through knife back and section

JOB SHEET #8

M. Drive rivets (Figure 47)

1. Hold rivet-setting tool in one hand
2. Strike tool with hammer, using firm, direct blows

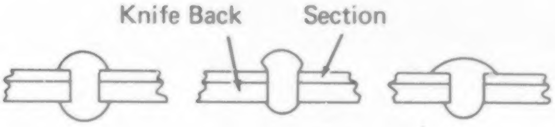
FIGURE 47



N. Check rivet head (Figure 48)

(NOTE: A rivet that is not properly formed will loosen and fail.)

FIGURE 48



RIGHT WRONG WRONG

Used with permission of Deere & Company, Moline, Illinois.

O. Repeat steps J-N, replacing every other section

(NOTE: Replacing alternate sections keeps the knife straight and keeps rivets from shifting when tightening sections on the knife back.)

P. Replace knife in cutter bar after all knife sections have been replaced

JOB SHEET #8

III. Replacing sections while knife is in cutter bar

(CAUTION: Be extremely careful. It is easy to lose fingers while working on a sickle blade.)

A. Block up cutter bar on wooden blocks

B. Shear off rivets with a cold chisel and ball peen hammer

C. Punch rivet stems out with pin punch

D. Remove section to be replaced

E. Align new section with knife back

F. Insert correct-sized rivet

G. Apply section clamp and tighten

(NOTE: If section clamp is not available, use a steel backing and a rivet-setting tool to drive the rivet.)

H. Drive rivet

I. Check rivet head

(NOTE: See Figure 48 on previous page.)

TRACTOR ATTACHMENTS
UNIT X

JOB SHEET #9--REPAIR A SICKLE KNIFE

I. Equipment and materials

A. Tractor equipped with a sickle mower

B. Mower operator's manual

C. Pump-type oil can and oil

D. Wooden blocks

E. Open or box wrenches

F. Vise

G. Bench grinder equipped with sickle grinding wheel, medium coarse grit

H. Recommended safety equipment

1. Hard hat
2. Close-fitting clothing
3. Hard-toed shoes
4. Gloves
5. Face shield or goggles

II. Procedure

A. Remove knife from cutter bar, using the following procedures

(CAUTION: Be extremely careful. Wear gloves to protect hands.)

1. Oil knife

2. Turn on engine and run knife back and forth for a minute to loosen any rust deposits

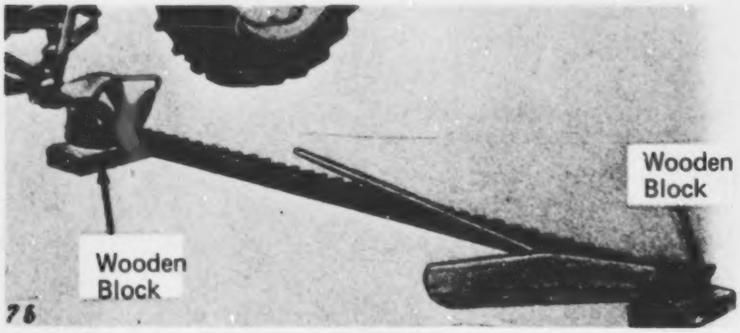
   (NOTE: If the knife is gummed up, spray water over the knife while it is running.)

3. Turn off engine

JOB SHEET #9

4. Block up cutter bar with wooden blocks (Figure 49)

FIGURE 49



Used with permission of Deere & Company, Moline, Illinois.

5. Remove connector from knife head according to manufacturer's recommendations

6. Using both hands, grasp knife on its back side away from knife sections

   (CAUTION: If sections hang up on the ledger plates, maneuver them with a wooden block, not your fingers.)

B. Straighten knife

1. Lay knife on a smooth, flat surface
2. Sight along edges to determine where knife is bent
3. Clamp knife in a vise
4. Bend carefully by hand

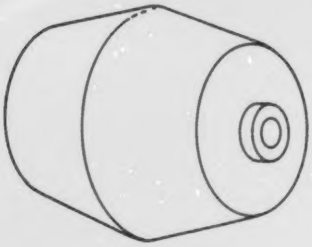
C. Sharpen knife

(CAUTION: Wear eye protection. Do not wear gloves.)

JOB SHEET #9

1. Inspect and dress sickle-grinding wheel (Figure 50)

FIGURE 50



Courtesy of Deere & Company, Moline, Illinois.

2. Keep shearing angle of section the same as that of original edge

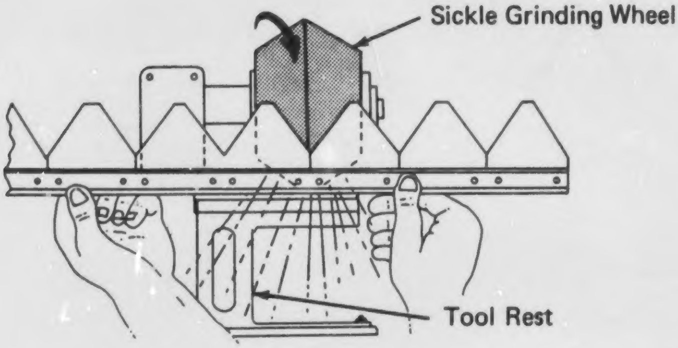
   (NOTE: Bevel face should be approximately 1/4 inch wide.)

3. Hold knife assembly in both hands and place lightly on wheel (Figure 51)

   (CAUTION: Do not overheat the section when grinding.)

   (NOTE: The knife back should rest on a stable, flat surface for easy control. The grinding wheel should turn *against* the edges of the sections so that feathering will not occur. See Figures 51 to 52.)

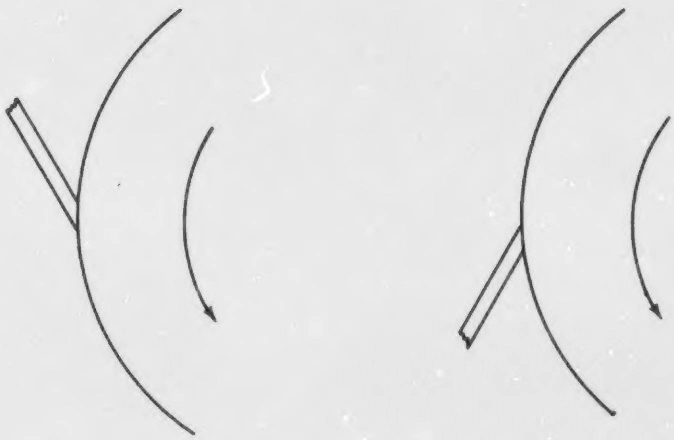
FIGURE 51



Used with permission of Deere & Company, Moline, Illinois.

JOB SHEET #9

FIGURE 52

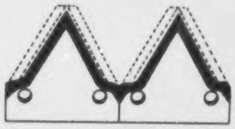


NO
Grinding toward cutting edge leaves a feather edge on cutting surface.

YES
Grinding away from cutting edge leaves a smooth cutting surface.

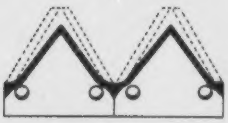
4. Check ground sections for proper angle (Figures 53-55)

FIGURE 53



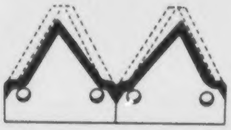
SECTIONS PROPERLY GROUND. Even after repeated grinding, proper bevel and angle are retained.

FIGURE 54



IMPROPERLY GROUND SECTIONS: Narrow bevel and wrong angle which changes the angle of "shear."

FIGURE 55



SECTIONS GROUND OFF CENTER, destroying the register of blade in guard.

Used with permission of Deere & Company, Moline, Illinois.

D. Replace knife section in cutter bar

(CAUTION: Wear gloves.)

DOT I - 941

TRACTOR ATTACHMENTS
UNIT X

JOB SHEET #10–OPERATE A POSTHOLE DIGGER

I. Equipment

- A. Tractor with posthole digger attached
- B. Tractor operator's manual
- C. Auger operator's manual
- D. Correct size shear bolts
- E. Wrenches or tool kit
- F. Recommended safety equipment
    1. Hard hat
    2. Close-fitting clothing
    3. Hard-toed shoes
    4. Earplugs
    5. Gloves
    6. Goggles

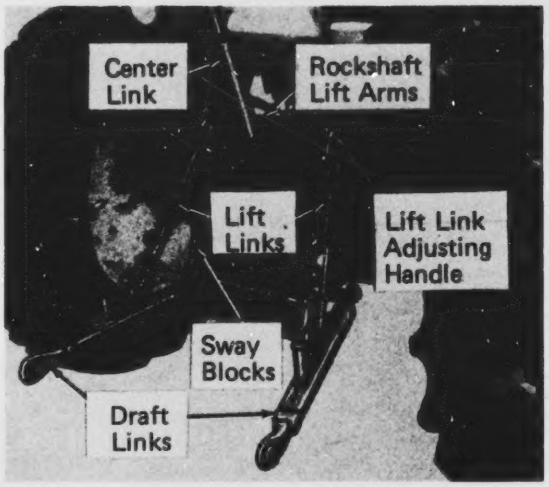
II. Procedure

- A. Check auger operator's manual and tractor operator's manual for hookup and daily maintenance requirements

JOB SHEET #10

B. Raise auger point off ground and adjust auger to vertical position by operating hand crank of adjustable lift link (Figure 56)

FIGURE 56


Center Link
Rockshaft Lift Arms
Lift Links
Lift Link Adjusting Handle
Sway Blocks
Draft Links

Used with permission of Deere & Company, Moline, Illinois.

C. Set tractor brakes

D. Operate remote hydraulic control lever to lower auger point slowly to ground

E. Engage PTO shaft clutch with engine at one-half throttle

(CAUTION: Do not overspeed auger.)

F. Lower auger into ground SLOWLY

(NOTE: The auger should carry dirt out of the hole rather than screw into the ground. In clay soils, hold back against the auger's suction action by moving the hydraulic control lever momentarily to either the hold or raise position.)

G. Lower auger 12 to 15 inches into ground; then raise it almost out of hole

H. Lower auger again and drill deeper; then raise it again

I. Repeat lowering and raising until desired hole depth is reached

JOB SHEET #10

J. Disengage PTO shaft and raise auger from hole

(NOTE: For heavy soil conditions or for tractors requiring PTO shaft rotation to produce lifting power, allow auger to turn at slow speed while raising it from hole.)

(CAUTION: Be sure area is cleared of all personnel.)

K. Replace broken shear bolts

(CAUTION: Turn off engine and wait for all movement to stop before working on auger.)

L. Tighten shear bolt nut

(NOTE: If auger becomes lodged on an underground obstruction, do not attempt to raise it by hydraulic lift power alone. Use a wrench on the universal shaft to turn the auger in reverse several times. After auger is freed, apply lift power and slowly rotate PTO shaft to raise auger.)

(CAUTION: Never road posthole digger with PTO shaft engaged.)

TRACTOR ATTACHMENTS
UNIT X

TEST

NAME ______________________________ SCORE __________

1. Match terms associated with tractor attachments to their correct definitions. Write the correct numbers in the blanks.

_____a. Notched or toothed on edge

_____b. Angle of cutter bar in relation to ground

_____c. Leaves, flowers, and branches

_____d. Means for giving motion to a part

_____e. Rotating earth drill on a posthole digger

_____f. Two surfaces coming together at an angle other than 90 degrees

_____g. Bar to which blades are attached on a sickle mower

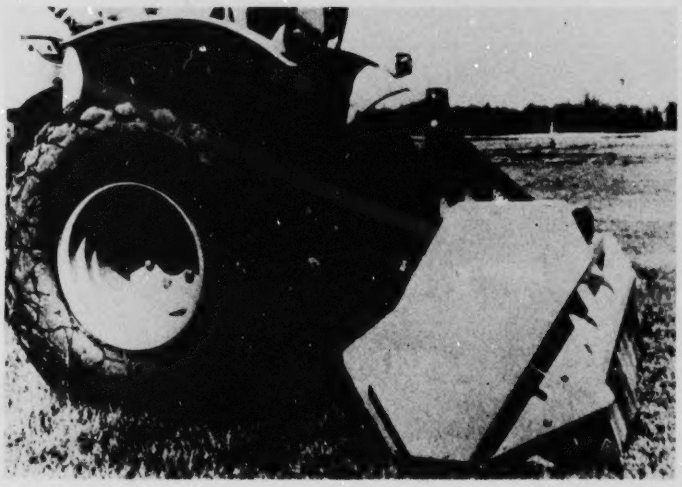
_____h. Tool for measuring thickness

_____i. Outer end of bar as set ahead of inner end

_____j. Side of a ditch away from road

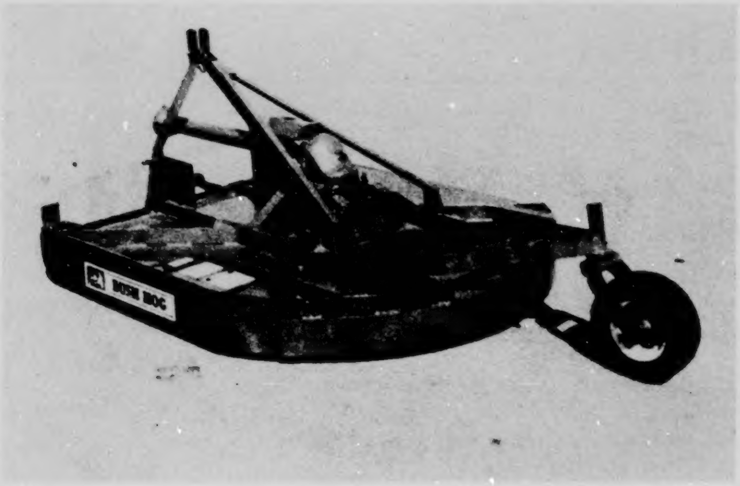
1. Bevel
2. Drive
3. Cutter bar
4. Cutter bar lead
5. Foliage
6. Tilt
7. Serrated
8. Backslope
9. Feeler gauge
10. Auger

2. Label tractor attachments and parts. Write the correct names in the blanks.

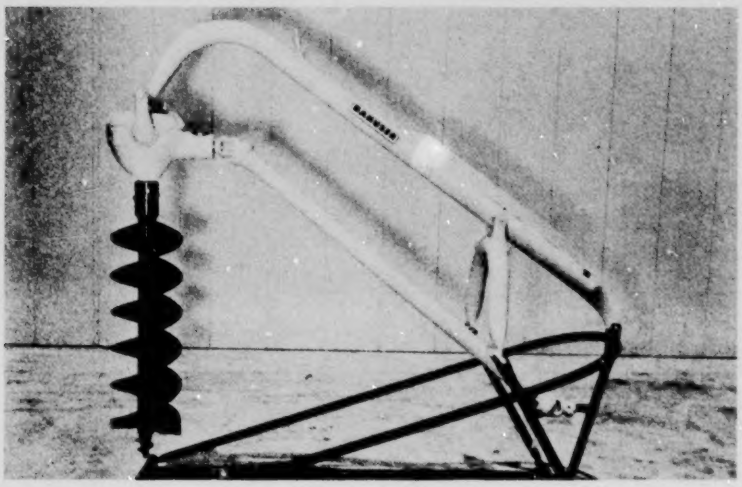


a. ______________________________--Used for smaller mowing jobs in populated areas

TEST

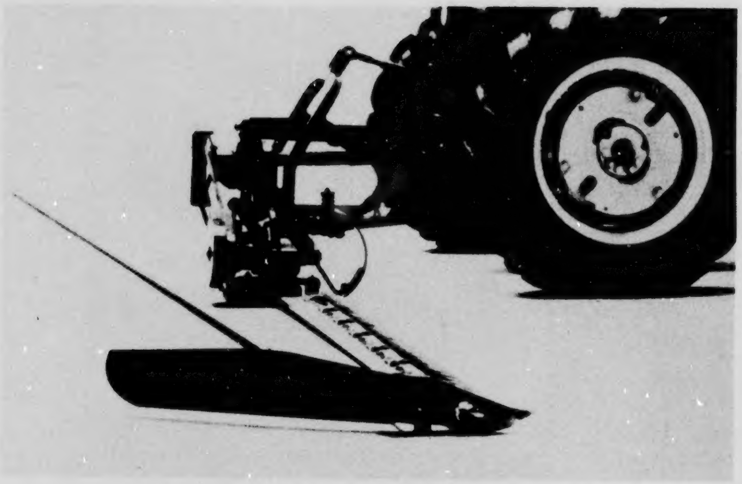


b. ______________________________--Used for mowing around guardrails, delineator posts, and bridge approaches

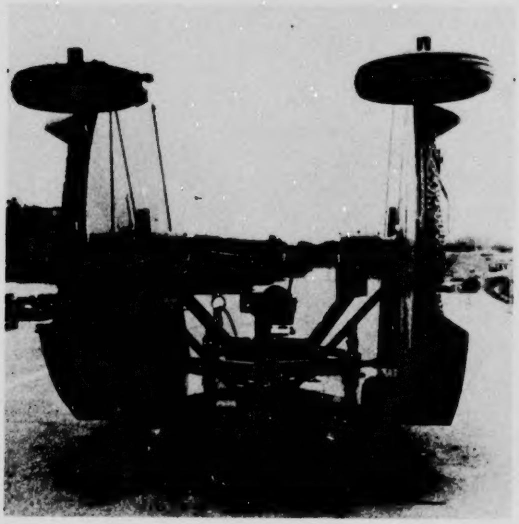


c. ______________________________--Used to dig holes for signposts and guardrails

TEST

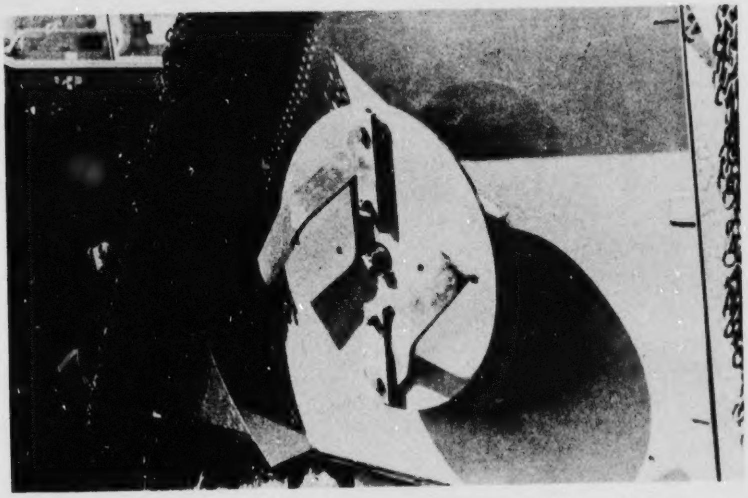


d. ______________________________--Used for trimming, mowing steep slopes, and mowing around culvert heads

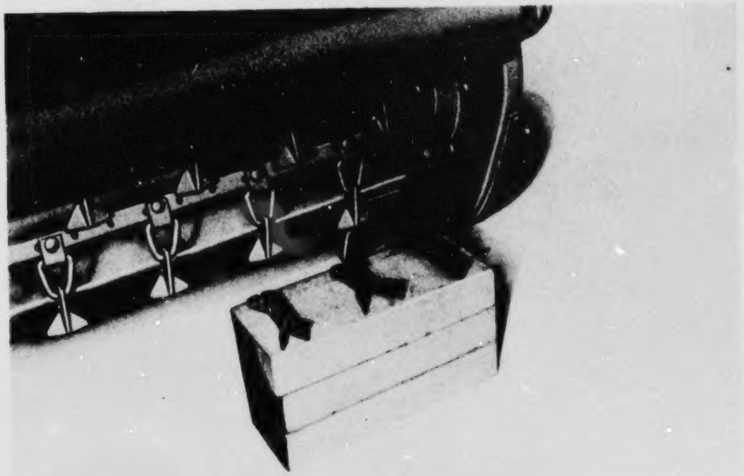


e. ______________________________--Used on medians, slopes, and for production mowing

TEST

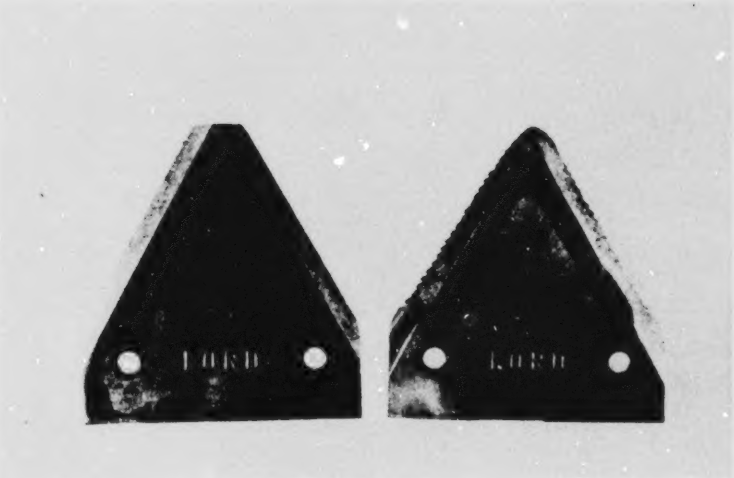


f. ____

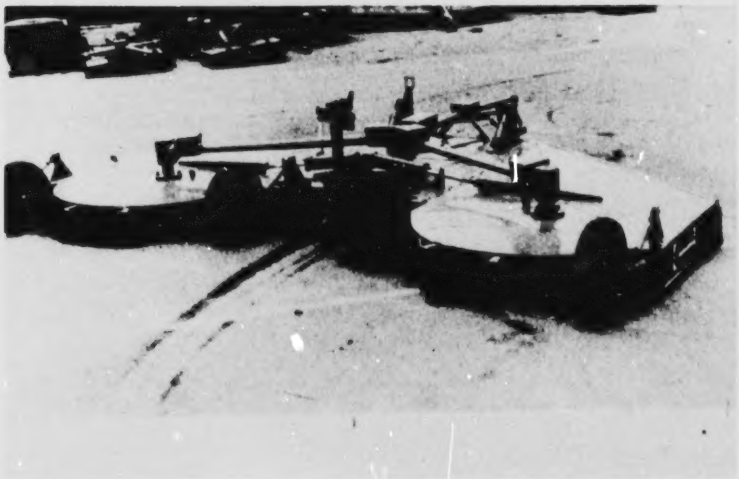


g. ____

TEST



h. ______________________________



i. ______________________--Used on medians, slopes, and for production mowing

TEST

3. State seven safety rules for mowing.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

4. Select from the following list techniques for effective mower operation. Write an "X" in the blank before each correct answer.

______a. Tilt a rotary mower 2 or 3 inches lower in front for rough cutting conditions

______b. Perform preventive maintenance when convenient

______c. Run the mower level under normal conditions

______d. Mow in direction that allows cut material to be thrown toward uncut area

______e. Run mower at highest possible rpm to increase production

______f. Mow recommended swath; cross roadway and mow other side; return and make second pass

______g. Mow with front end slightly raised on rough terrain

______h. Be sure all guards are secure and in good operating condition

______i. Operate mower at highest position that will give desired cutting results

______j. Operate mower at lowest position that will give desired cutting results

______k. Check height of cut by turning one blade of rotary mower to front of mower, enabling you to see height of blade from ground

______l. Mow across steep slopes

______m. If blades dig into ground, disengage PTO and move tractor forward or backward until blades are clear

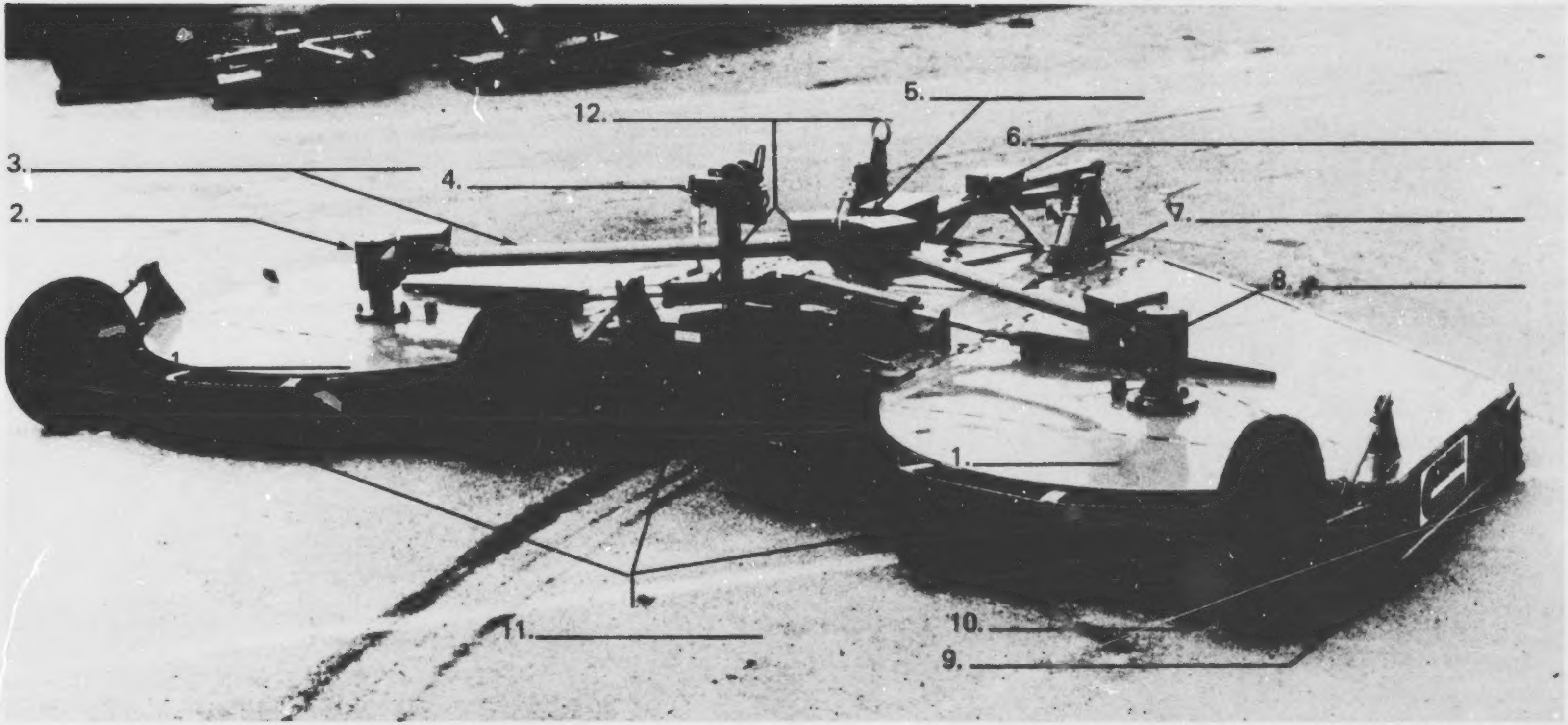
______n. Keep PTO engaged when crossing the highway on turnarounds

TEST

5. Identify parts of a rotary mower. Write the correct numbers in the blanks.

PTO-driven rotary mower

______a. Height adjustment
______b. Wheel axle arm
______c. Center gear box
______d. Wing lift assemblies
______e. Chain guards
______f. Left wing gear box
______g. Canopy
______h. Drive shaft from PTO to center gear box
______i. Clearance adjustment
______j. Right-wing telescoping drive shaft
______k. Left-wing telescoping drive shaft
______l. Right wing gear box



TEST

Hydraulic Rotary Mower

______ a. Skid shoe

______ b. Hydraulic cylinders

______ c. Winch

______ d. Tongue assemby

______ e. Chain guard

______ f. Hydraulic pump assembly

______ g. Level lift rod

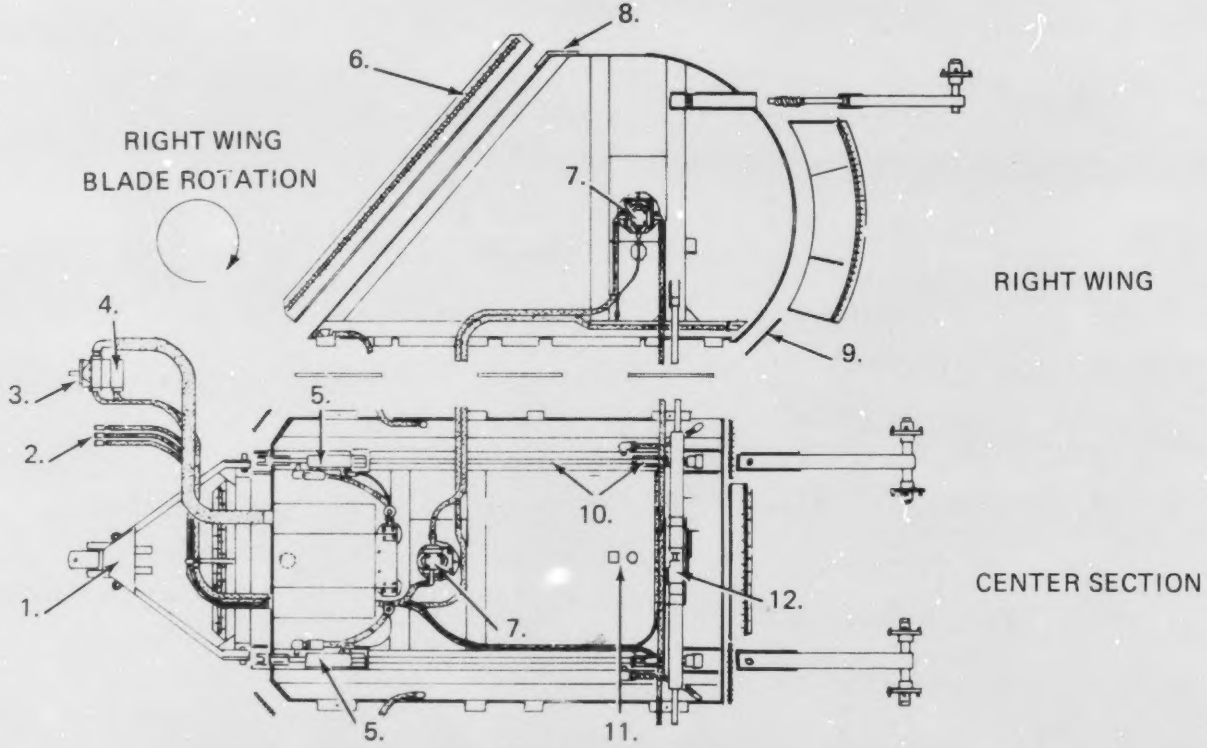
______ h. PTO speed changer

______ i. Rubber flap

______ j. Jack assembly

______ k. Hydraulic motor

______ l. Hydraulic control valves


8.
6.
RIGHT WING
BLADE ROTATION
7.
RIGHT WING
4.
9.
3.
5.
2.
10.
CENTER SECTION
1.
12.
7.
5.
11.

TEST

6. Identify parts of a flail mower. Write the correct numbers in the blanks.

_____a. Gauge roller

_____b. Rotor

_____c. Knife

_____d. Stand

_____e. PTO shield

_____f. PTO drive line assembly

_____g. Mast

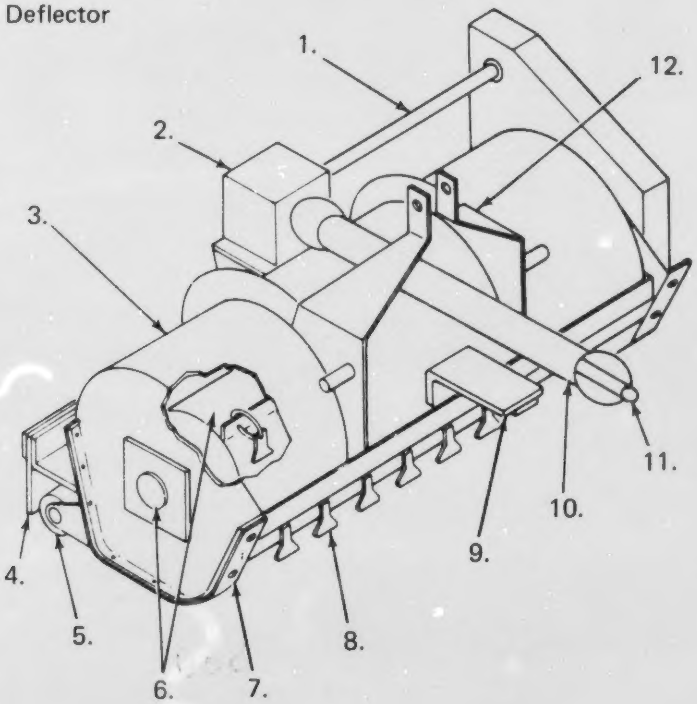
_____h. Skid shoe

_____i. Housing

_____j. Gear box

_____k. Drive mechanism

_____l. Deflector



TEST

7. Match parts of a cutter bar to their correct functions. Write the correct numbers in the blanks.

______a. Protects knife and acts as stationary shearing edge for moving section

______b. Cutting part of guard

______c. Connecting point between knife and drive

______d. Supports knives, clips, and wear plates

______e. Individual cutting unit

______f. Gauging mechanisms that hold cutter bar off the ground at desired cutting height

______g. Holds knife snugly against ledger plates for clean cutting

______h. Cutting blade

______i. Acts as guide for knife back, keeping it properly aligned with ledger plate so that shearing action can be maintained

1. Knife section
2. Knife head
3. Wear plate
4. Inner and outer shoes
5. Ledger plate
6. Bar
7. Knife
8. Knife clip
9. Guard

8. Select from the following list general procedures for mower maintenance. Write an "X" in the blank before each correct answer.

______a. Check that all hardware is tightened securely before each use

______b. Know lubrication schedule

______c. Keep blades sharp

______d. Check blades for proper size and cutting angle

______e. Clear grass, chaff, or other matter from mower after each cutting operation

______f. Check universal joint for wear while mower is engaged

______g. Let hydraulic system support wings while servicing a rotary mower

______h. Make sure that all grease fittings are properly lubricated

TEST

9. Select from the following list steps for sharpening mower blades. Write an "X" in the blank before each correct answer.

_____a. Wear gloves

_____b. Wear safety goggles

_____c. Dip blade frequently in water to cool

_____d. Use oilstone, grindstone, or file

_____e. Operate so that grinding wheel turns away from cutting edge

_____f. Move blade back and forth against grinding wheel

_____g. Hold tool *lightly* against wheel to prevent overheating

_____h. Leave a feathered or wired edge on the blade for sharper cutting

_____i. Check blade manual for angle

10. Select from the following list components that need adjusting on a sickle mower cutter bar. Write an "X" in the blank before each correct answer.

_____a. Outer shoe angle

_____b. Cutter bar tilt

_____c. Ledger plates

_____d. Inner shoe angle

_____e. Knife head guides

_____f. Operating height

_____g. Knife back clearance

_____h. Cutter bar lead

_____i. Guards

_____j. Knife angle

_____k. Guard lip clearance

_____l. Hold-down clips

_____m. Wear plates

TEST

11. Select from the following list maintenance procedures for a sickle mower. Write an "X" in the blank before each correct answer.

_____a. Keep knives clean

_____b. Service drive mechanisms at manufacturer's recommended intervals

_____c. Keep inner and outer shoes properly lubricated

_____d. Keep wear plates, knife hold-down clips, and knife-head guides in adjustment

_____e. Remove guards and check cutting edges at recommended intervals

_____f. Maintain proper lead angle

_____g. Keep knives sharp

12. State seven safety precautions for operating a posthole digger.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

13. Select from the following list techniques for operating a posthole digger. Write an "X" in the blank before each correct answer.

_____a. Speed auger to fastest operating speed once it digs into ground

_____b. Clear auger frequently after it has dug deep enough into ground to be loaded with dirt (about one foot)

_____c. Road auger with PTO engaged

_____d. Run engine at slow speed until auger digs into ground and type and texture of soil is determined

_____e. Use wheel chocks

_____f. When auger gets stuck, reverse PTO and back out auger

_____g. Take extra care to position auger shaft at proper angle on hillside or extremely uneven terrain

TEST

14. Match techniques for operating a posthole digger to correct soil conditions. Write the correct numbers in the blanks. Problem may have more than one correct answer.

______a. Increase power, lower speed of auger and reverse auger rotation quickly to loosen material

______b. Use augers with sharp points and cutting blades

______c. Provide a firm foundation for tractor; do not attempt to lift as much dirt as in normal operation

1. Rocky soil
2. Wet earth or mud
3. Frozen earth
4. Sticky soil or clay

(NOTE: Test question 15 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

15. Demonstrate the ability to

a. Operate a rotary mower with PTO drive.

b. Operate a hydraulic rotary mower.

c. Repair a rotary mower blade.

d. Operate a flail mower.

e. Reverse or replace flail mower knives.

f. Adjust cutter bar on a sickle mower.

g. Operate a sickle mower.

h. Replace sickle knife sections.

i. Repair a sickle knife.

j. Operate a posthole digger.

TRACTOR ATTACHMENTS
UNIT X

ANSWERS TO TEST

1. a. 7
   b. 6
   c. 5
   d. 2
   e. 10
   f. 1
   g. 3
   h. 9
   i. 4
   j. 8

2. a. Flail mower
   b. Small (5-foot) rotary mower
   c. Posthole digger
   d. Sickle mower
   e. Large (15 to 20 foot) rotary mower--travel position
   f. Rotary mower blades
   g. Flail mower blades
   h. Sickle mower blades
   i. Large (15 to 20 foot) rotary mower--operating position

3. Answer should include any seven of the following
   a. Place warning signs at both ends of mowing area
   b. Mow with traffic
   c. Keep alert to traffic
   d. Mow up and down the face of a steep slope
   e. Mount and dismount with care
   f. Shut down mower when any person or animal approaches
   g. Work at a safe distance from spectators and other workers
   h. Never clean, oil, or adjust mower when it is running
   i. Always lower three-point hitch when shutting off tractor engine

ANSWERS TO TEST

j. Be sure power shaft and master shields are in place

k. Disengage PTO when mower is not in operation

l. Disengage PTO before dismounting tractor

m. Be sure all guard devices are in good working order

4. a, c, d, f, h, i, k, m

5. **PTO-driven rotary mower**

a.	4	g.	1
b.	10	h.	6
c.	5	i.	9
d.	12	j.	7
e.	11	k.	3
f.	2	l.	8

Hydraulic rotary mower

a.	8	g.	10
b.	5	h.	3
c.	12	i.	9
d.	1	j.	11
e.	6	k.	7
f.	4	l.	2

6.

a.	5	g.	12
b.	6	h.	7
c.	8	i.	3
d.	9	j.	2
e.	10	k.	1
f.	11	l.	4

7.

a.	9	f.	4
b.	5	g.	8
c.	2	h.	7
d.	6	i.	3
e.	1		

8. a, b, c, e, h

ANSWERS TO TEST

9. b, c, d, g, i

10. b, e, f, h, i, k, l, m

11. a, b, d, f, g

12. Answer should include any seven of the following

    a. Wear gloves and safety goggles or face shield during assembly, operation, installation, adjustment, or removal

    b. Wear close-fitting clothes

    c. Keep guards and safety shields in place during operation

    d. Do not operate PTO with tractor safety shield removed

    e. Shut off tractor engine, set brakes, and lower implement to the ground before leaving tractor seat

    f. Keep spectators clear of auger when in operation

    g. Do not oil or adjust auger while in operation

    h. Operate all PTO-powered augers at 540 rpm unless otherwise advised

    i. Do not attempt to operate auger on steep hillsides

    j. Reduce speed while driving over rough ground

    k. Use tools designed for the specific task you are performing

    l. Keep all bolts and nuts tight

    m. Replace any damaged or worn parts immediately

    n. Use support jacks when operating auger in difficult soil conditions

    o. Post warning signs at open holes

13. b, d, e, g

14. a. 4

    b. 1, 3

    c. 2

15. Performance skills evaluated to the satisfaction of the instructor

FRONT-END LOADERS
UNIT XI

UNIT OBJECTIVE

After completing this unit, the student should safely and effectively be able to operate a front-end loader to perform several types of jobs. This knowledge will be shown by completing assignment sheet, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with front-end loaders to their correct definitions.
2. Select from a list types of jobs performed with front-end loaders.
3. Identify types of front-end loaders.
4. Label accessories used on front-end loaders.
5. Label basic parts of a wheel loader.
6. Identify controls on a typical front-end loader.
7. Match controls on a typical front-end loader to their correct functions.
8. Identify typical boom and bucket control positions.
9. Match four-in-one (multipurpose) bucket functions to their correct uses.
10. State safety rules for operating a front-end loader.
11. Select from a list suggestions for effective loader operations.
12. Select from a list procedures for digging.
13. State procedures for loading.
14. Select from a list procedures for leveling and grading.
15. List in order lever positions for loading operations.
16. Demonstrate the ability to
    a. Perform prestart inspection and maintenance procedures.
    b. Service a front-end loader.
    c. Start, warm-up, operate, and shut down a front-end loader.
    d. Perform digging operations.

OBJECTIVE SHEET

e. Perform loading operations.

f. Perform dozing operations.

g. Dig a pit.

FRONT-END LOADERS
UNIT XI

SUGGESTED ACTIVITIES

I. Suggested activities

   A. Order materials to supplement unit.

      1. Films

         a. *Loading Logic.* 16 mm, (Modern Talking Picture Service, Inc.,) n.d. Available from Caterpillar Film Library, 1687 Elmhurst Road, Elk Grove Village, Illinois 60007.

            (NOTE: This film is about moving the greatest amount of material in the shortest possible time at the lowest possible cost. It explains the many practical loader and truck techniques that improve efficiency and increase production. Designed as an instructional tool, the film may be stopped at built-in breaks for discussion. Request #30358--*Loading Logic*.)

         b. *Operating Tips: Wheel Loaders.* 16mm, Modern Talking Picture Service, Inc., n.d. Available from Caterpillar Film Library, 1687 Elmhurst Road, Elk Grove Village, Illinois 60007.

            (NOTE: In this film, an experienced operator-demonstrator explains the basic responsibilities that go with the equipment operation. Request #30819--*Operating Tips: Wheel Loaders.)*

      2. Contact local heavy equipment distributors for sales literature showing color photographs of front-end loaders, such as John Deere, JI Case, International Harvester, or Caterpillar.

   B. Provide students with objective sheet.

   C. Provide students with information, assignment, and job sheets.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Provide alternative jobs if job sheets are not practical.

   H. Arrange a field trip to observe loader operations.

   I. Make a model of boom and bucket controls for students to practice coordination.

      (NOTE: If controls on equipment students use are different from controls in this unit [John Deere], make diagrams to illustrate Objective 8 and Assignment Sheet #1.)

SUGGESTED ACTIVITIES

J. Make a field trip to a maintenance yard to show students rigid and articulated loaders, and their advantages and hazards.

K. Give test.

II. Instructional materials

A. Objective sheet

B. Suggested activities

C. Information sheet

D. Assignment Sheet #1--List in Order Lever Positions for Loading Operations

E. Answers to assignment sheet

F. Job sheets

1. Job Sheet #1--Perform Prestart Inspection and Maintenance Procedures

2. Job Sheet #2--Service a Front-End Loader

3. Job Sheet #3--Start, Warm Up, Operate, and Shut Down a Front-End Loader

4. Job Sheet #4--Perform Digging Operations

5. Job Sheet #5--Perform Loading Operations

6. Job Sheet #6--Perform Dozing Operations

7. Job Sheet #7--Dig a Pit

G. Test

H. Answers to test

III. Unit references

A. Nichols, Herbert L., Jr. *Moving the Earth,* 3rd ed. Greenwich, Connecticut: North Castle Books, 1976.

B. *Operator's Manual: John Deere JD544-B Loader.* OM-T68748, Issue K9. Moline, Illinois: John Deere Distribution Center, n.d.

(NOTE: The above manual is available from John Deere Distribution Service Center, Department S/P, 1400 Third Avenue, Moline, Illinois 61265.)

FRONT-END LOADERS
UNIT XI

INFORMATION SHEET

I. Terms and definitions

A. Articulated--Jointed

B. Ram--Hydraulic cylinder

C. Accessories--Attachments used to increase a machine's versatility and effectiveness

D. Detent--Device for holding a lever in position

E. Stockpile--Materials put into a pile and saved for future use

F. Fill--Raising elevation of the ground to desired level; soil material

G. Float--Gear position that allows bucket to follow the contour of the surface

H. Road--To travel equipment under its own power

I. Transport--To travel equipment by loading it on another vehicle

J. Turbocharger--Exhaust-driven centrifugal air compresser used to increase engine power

K. Cycle--To repeat the same steps or procedures

L. Backfill--To refill a ditch or other excavation; material used for refilling

II. Types of jobs performed with front-end loaders (Job Sheets #4-#7)

A. Loading trucks

B. Stockpiling

C. Rough grading

D. Digging

E. Hauling materials and equipment

F. Removing snow

G. Backfilling

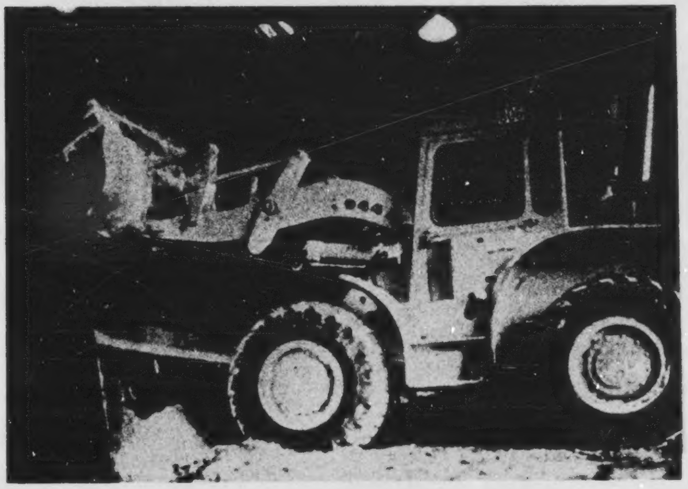
H. Finish grading

INFORMATION SHEET

III. Types of front-end loaders (Figures 1-3)

A. Rigid-frame wheel loader

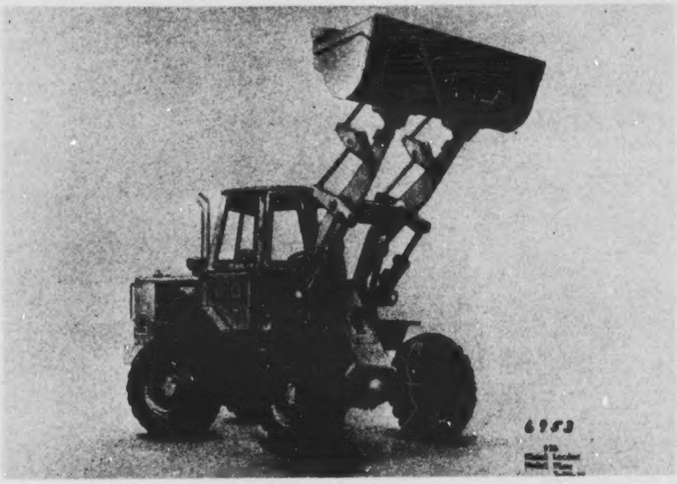
FIGURE 1



Courtesy of Caterpillar Tractor Company.

B. Articulated wheel loader

FIGURE 2

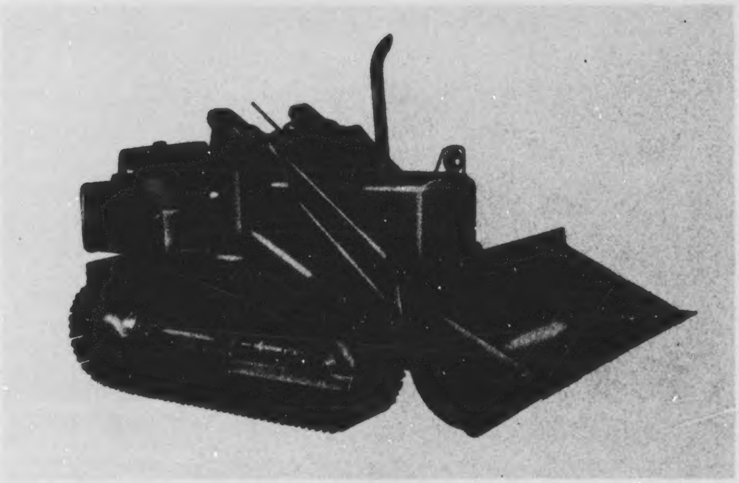


Courtesy of Caterpillar Tractor Company.

INFORMATION SHEET

C. Crawler loader

FIGURE 3



Courtesy of Deere & Company, Moline, Illinois.

IV. Accessories used on front-end loaders (Figures 4 and 5)

A. Standard bucket

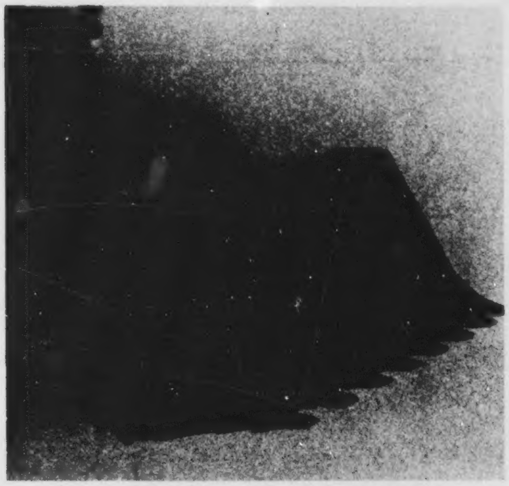
FIGURE 4

Courtesy of Deere & Company, Moline, Illinois.

INFORMATION SHEET

B. Four-in-one bucket (multipurpose bucket)

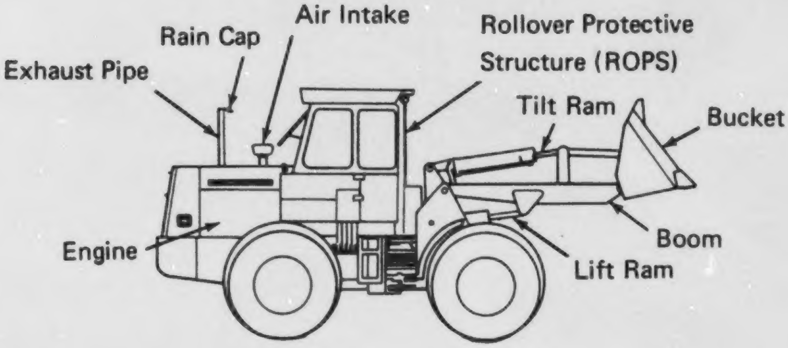
FIGURE 5



Courtesy of Deere & Company, Moline, Illinois.

V. Basic parts of a wheel loader (Figure 6; Job Sheets #1 and #2)

FIGURE 6


Air Intake
Rain Cap
Exhaust Pipe
Rollover Protective Structure (ROPS)
Tilt Ram
Bucket
Engine
Boom
Lift Ram

Used with permission of Deere & Company, Moline, Illinois.

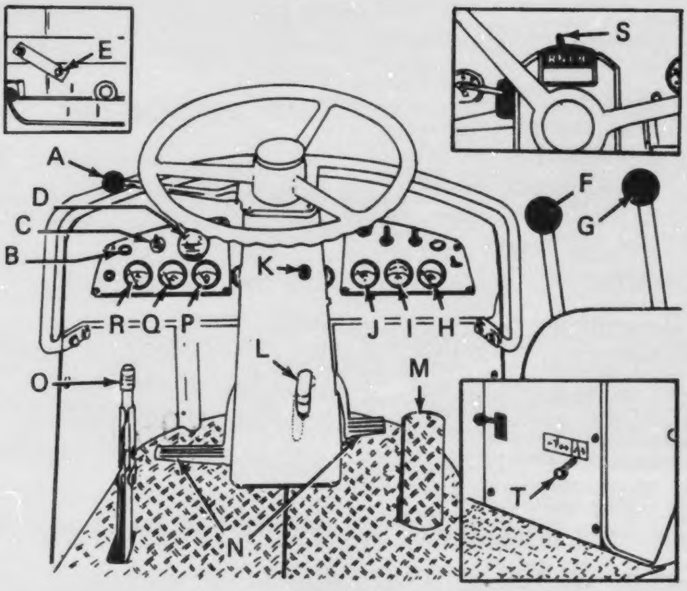
INFORMATION SHEET

VI. Controls on a typical front-end loader (Figure 7; Job Sheet #3)

(NOTE: This loader has a single lever for boom and bucket controls. Some models are equipped with two controls: one to raise or lower the boom, and one to dump and retract the bucket.)

A. Shift lever
B. Starter button
C. Key switch
D. Hourmeter
E. Axle disconnect (located behind seat)
F. Boom/bucket control lever
G. Attachment control lever
H. Engine oil pressure gauge
I. Ammeter
J. Engine coolant temperature gauge
K. Horn button
L. Diesel starting fluid adapter
M. Accelerator
N. Brake pedals
O. Parking brake
P. Fuel gauge
Q. Transmission pressure gauge
R. Transmission temperature gauge
S. Range indicator
T. Clutch cutoff control lever (located on side of seat)

FIGURE 7



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INFORMATION SHEET

VII. Functions of controls on a typical front-end loader

A. Accelerator--Controls engine rpm and travel speed

(NOTE: Check operator's manual for normal operating rpm.)

B. Brake pedal--Stops loader

C. Shift lever--Selects gears

D. Axle disconnect--Disengages rear axle for maximum speed when roading loader

E. Boom-bucket control lever--Controls height and direction of boom and bucket

(NOTE: Some models have separate boom and bucket controls.)

F. Attachment control lever--Controls four-in-one bucket or other types of auxiliary equipment

G. Diesel starting fluid adapter--Aids in cold-weather starting

H. Parking brake--Secures loader when engine is idling or when loader is parked

I. Range indicator--Shows reverse, neutral, high or low gear range selected

J. Clutch cutoff control lever--Speeds loading operations by disconnecting transmission clutches when brake pedal is depressed

(CAUTION: The clutch cutoff control lever should be in the ALWAYS ENGAGED position when roading the loader. PEDAL CONTROL position should be used for loading and dumping operations only. Use ALWAYS ENGAGED position when stopping on steep inclines.)

INFORMATION SHEET

VIII. Typical boom and bucket control positions (Figures 8-10; Assignment Sheet #1)

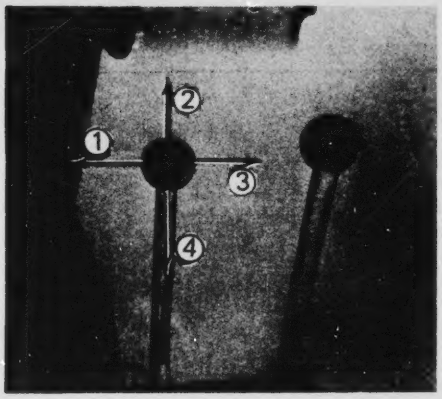
(NOTE: Boom and bucket control is the skill to be mastered in operating a front-end loader. Coordination and mastery come with practice. This objective covers single-lever operation. All functions are controlled by moving the lever to different positions. Check operator's manual for specific procedures.)

A. Standard operation

(NOTE: Dumping and retracting speeds are controlled by the distance the control lever is moved.)

1. Retract bucket
2. Lower boom
3. Dump bucket
4. Raise boom

FIGURE 8



Courtesy of Deere & Company, Moline, Illinois.

INFORMATION SHEET

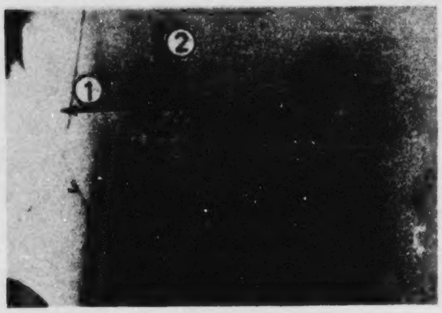
B. Detent operation

(NOTE: The detent holds the lever at a preset position. The lever will return to neutral when released.)

(CAUTION: Never lower a loaded bucket with control lever in float position.)

1. Return-to-dig detent
2. Float position detent

FIGURE 9



Courtesy of Deere & Company, Moline, Illinois.

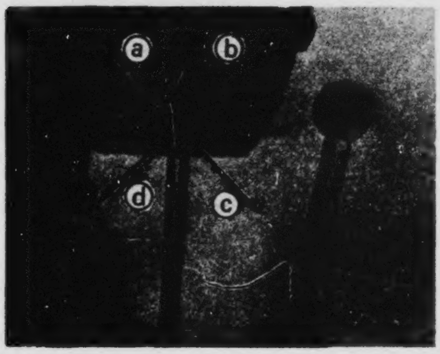
INFORMATION SHEET

C. Boom and bucket combined

(NOTE: Combined operating reduces cycle time by activating both boom and bucket in one operation.)

1. Lower boom--retract bucket
2. Lower boom--dump bucket
3. Raise boom--dump bucket
4. Raise boom--retract bucket

FIGURE 10



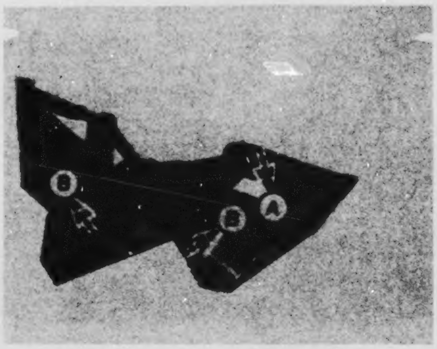
Courtesy of Deere & Company, Moline, Illinois.

IX. Uses of four-in-one (multipurpose) bucket functions (Figures 11-14; Assignment Sheet #1)

A. Clamshell--Used for picking up materials from an overhead position

(NOTE: Raise clamshell over stockpile, then lower it until contact is made. It is helpful at times to hook clamshell over pile and back away, closing clam as you go.)

FIGURE 11



Courtesy of Deere & Company, Moline, Illinois.

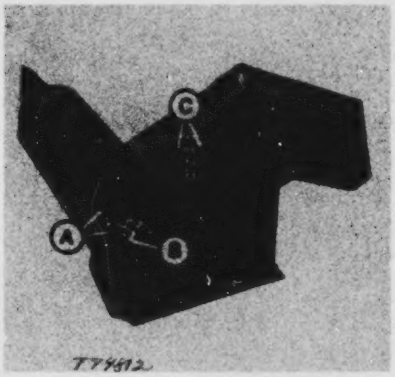
INFORMATION SHEET

B. Dozer--Used for pushing soil and materials, stockpiling, moving stumps and rocks

EXAMPLE: Fully open clam to convert multipurpose bucket to a dozer blade.

(NOTE: For deeper cuts, tilt forward; for a lesser degree of cut, tilt back.)

FIGURE 12



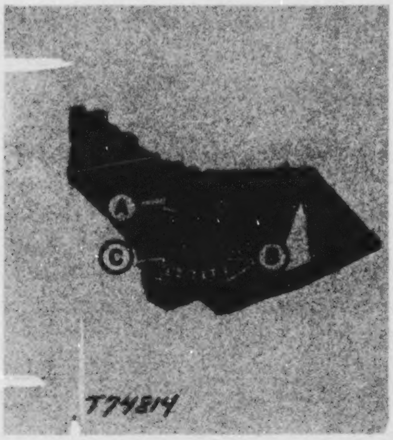
Courtesy of Deere & Company, Moline, Illinois.

C. Scraper--Used for leveling and grading

EXAMPLE: Partially open clam to form multipurpose bucket into a scraper.

(NOTE: The degree to which clam is open determines depth of cut. When bucket has been loaded, tilt it all the way back and close clam.)

FIGURE 13

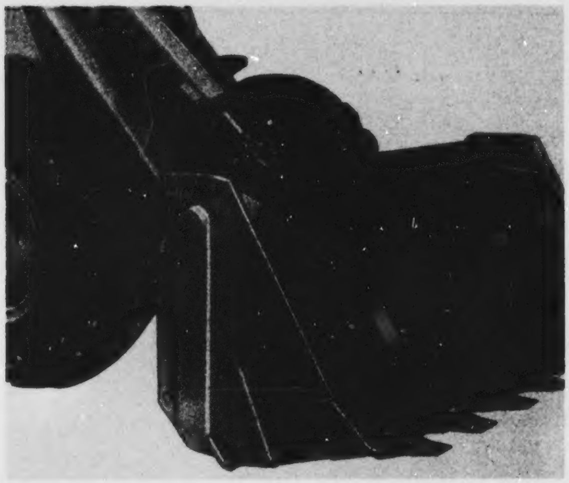


Courtesy of Deere & Company, Moline, Illinois.

INFORMATION SHEET

D. Bucket--Used for standard front-end loader operations

FIGURE 14



Courtesy of Deere & Company, Moline, Illinois.

X. Safety rules for operating a front-end loader

(NOTE: Know the rules and live by them. Do not learn safety the hard way.)

A. Read operator's manual thoroughly; know your machine

B. Study departmental safety regulations

C. Wear close-fitting clothing

D. Do not permit unauthorized people in work area while equipment is operating

E. Travel at safe operating speeds

F. Make sure all warning devices are working properly

G. Always use warning signs and proper control procedures

H. Keep bucket as close to the ground as possible when transporting loads

(NOTE: The nearer to the ground the bucket is held, the better the stability, especially on slopes or when turning the machine. For travel, keep the bucket about 15 inches off the ground and tipped back so that vision is not blocked.)

(CAUTION: Never transport a load with the bucket fully raised.)

INFORMATION SHEET

I. Lower the bucket to the ground when the loader is stopped or unattended

J. Check all component hinge pins and their devices frequently

(NOTE: Grease pins daily, more often in dusty operations.)

K. Never perform service or repairs on equipment that has not been properly blocked, tagged, and secured

(NOTE: Equipment is to be parked before being serviced or repaired; it *must* be tagged.)

L. Follow departmental preventive maintenance program when servicing equipment

M. When servicing, repairing, or transporting an articulated loader, be sure to insert locking pin

N. Never lift the bucket over the ground crew

O. Never swing the bucket over the truck cab

P. Release hydraulic pressure from an articulated loader by moving the steering wheel back and forth after the machine is shut down

Q. Use extra caution when conditions require it

EXAMPLES:

1. Rough terrain which can cause loader to tip
2. Excavation sites where loader may get too close to the edge

   (CAUTION: Be alert for underground wires and pipes.)

3. Slippery surfaces where traction is reduced
4. Near overheard power lines

   (CAUTION: Do not operate within 10 feet of power lines. Boom does not have to come into contact with wires to act as a conductor.)

5. Near underground power, gas, or telephone lines (utility and telephone companies will flag the work site if necessary with colored flags: gas and chemicals, *yellow;* phone, *orange;* electric, *red*; water, *blue;* sanitary and storm sewers, *green.*)

XI. Suggestions for effective loader operations (Job Sheets #1 and #4-#7)

A. Perform all prestart inspection and service procedures

B. Plan work cycle so that it will be as short as possible

INFORMATION SHEET

C. Keep distance from load to dump as short as possible

D. Carry bucket just high enough to clear obstacles when transporting a load

E. Raise the boom slowly so that the bucket will just reach dumping height at the time it arrives at the dump area

F. Lower boom to transport position as soon as bucket clears obstacles at dump site

G. Fill truck gradually from far side to near side

H. Load with wind at your back when possible

I. If possible, carry loaded bucket uphill when traveling on an incline

J. When transporting loader, cover rain cap to protect turbocharger

(NOTE: Wind will turn blades and heat turbocharger unit.)

XII. Procedures for digging (Job Sheets #4 and #7)

A. Have bucket flat or tilted slightly downward

(NOTE: This gives maximum penetration into banks and high spots and cuts a smooth path for the loader to follow.)

B. Cut into hard ground by tipping the bucket downward 10° to 30°

(NOTE: When loader has penetrated to a depth of two to six inches, bucket should be leveled as loader moves forward until bucket is filled.)

C. Do not push into solid obstructions with bucket at a steep angle

(NOTE: Bucket is at its weakest point when operated at a steep angle.)

D. Use bucket cylinder to break ground loose rather than using only forward movement of the loader

E. Do not raise bucket higher than necessary to fill it

F. Use as flat a ramp as possible when starting an excavation

(NOTE: Plan cycle so that most of the work can be done driving the loader forward out of the excavation rather than backing it. A steeper ramp can be used when driving forward than when driving in reverse.)

G. Use only sufficient bucket digging angle to fill bucket easily

INFORMATION SHEET

XIII. Procedures for loading (Job Sheet #5)

A. Keep bucket low when carrying a load

B. Always watch for material falling off the back of the bucket when the bucket is in a high position

C. Raise bucket when moving toward truck

D. Dump bucket when it is over the bed

E. Back up and retract bucket as soon as dumping is complete

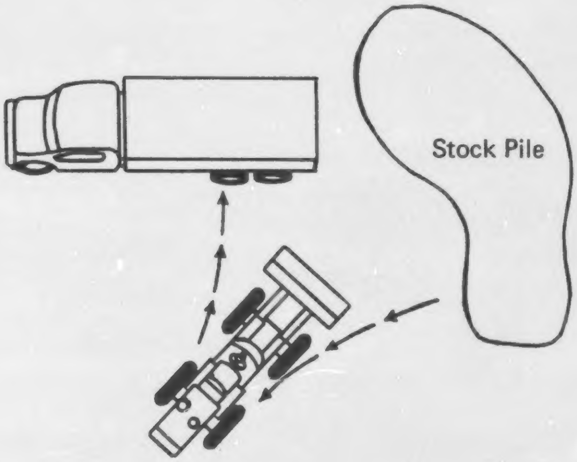
F. Lower the bucket when moving away from truck

G. Keep working areas smooth

H. Use "V" loading method to minimize turning (Figure 15)

EXAMPLE:

FIGURE 15



Used with permission of Deere & Company, Moline, Illinois.

I. Shake bucket only when necessary to loosen material lodged in bottom

XIV. Procedures for leveling and grading (Job Sheet #6)

A. Let material spill from partly open bucket held close to the ground for even spread

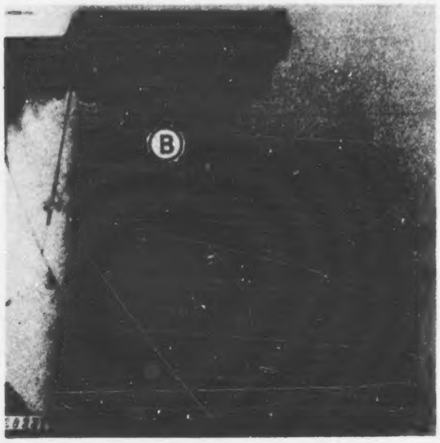
B. Rough grade by filling holes and low places and loosening high places

INFORMATION SHEET

C. Finish grade by running loader in reverse with bucket open and control lever in float position (Figure 16)

(NOTE: Float position allows the boom to move up or down as bucket follows contour of ground.)

FIGURE 16



Float Position

Courtesy of Deere & Company, Moline, Illnois.

FRONT-END LOADERS
UNIT XI

ASSIGNMENT SHEET #1--LIST IN ORDER LEVER POSITIONS FOR LOADING OPERATIONS

NAME ______________________________ SCORE ______________

Coordinating boom and bucket operation is the most important factor in safe and efficient loader operations. As you complete this assignment sheet, *visualize* where the shift lever goes, *move* your hand and arm through each position.

Move control lever forward to lower boom (C) and backward to raise boom (G).

(NOTE: Releasing control lever at any time during normal loader operation will automatically return lever to neutral, holding boom in position reached at that time.)

The bucket retracts when control lever is moved to left (A), and dumps when control lever is moved to right (E).

(NOTE: Dumping and retracting speed is controlled by distance the control lever is moved. Move lever only partially to the right for most accurate control and maximum power of bucket cutting edge. When retracting the bucket, maximum power is obtained by moving lever all the way to the left.)

A. Retract bucket

B. Lower boom - retract bucket

C. Lower boom

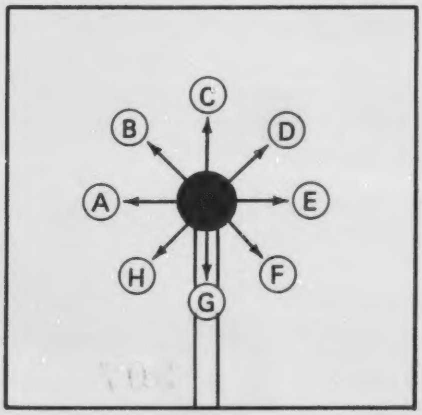
D. Lower boom - dump bucket

E. Dump bucket

F. Raise boom - dump bucket

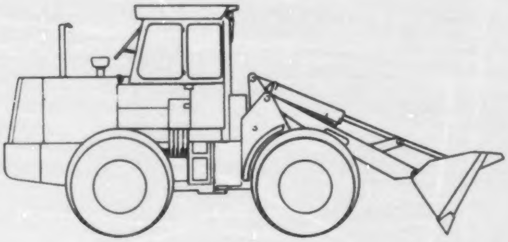
G. Raise boom

H. Raise boom - retract bucket

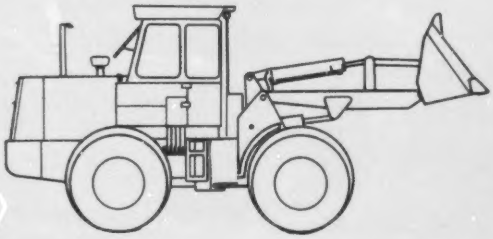


ASSIGNMENT SHEET #1

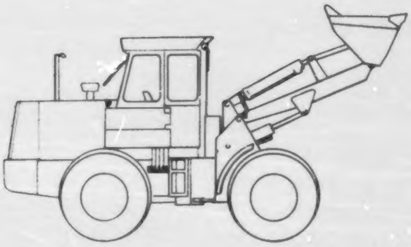
For each loading operation pictured below, write in the boom position (raised or lowered), the bucket position (retracting or dumping), and the control lever position for each move. Use the diagram on the previous page or a diagram provided by your instructor, and write in the letter which represents the correct position.



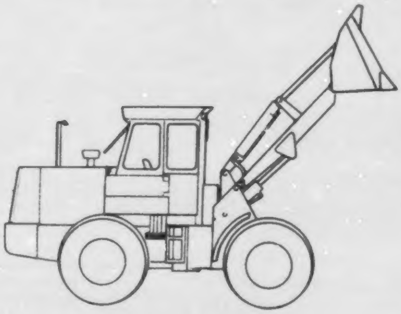
A.
1. Boom--____________________
2. Control lever--________________
3. Bucket--____________________
4. Control lever--________________



B.
1. Boom--______________________
2. Control lever--________________
3. Bucket--______________________
4. Control lever--________________



C.
1. Boom--____________________
2. Bucket--___________________
3. Control lever--________________



D.
1. Boom--______________________
2. Bucket--_____________________
3. Control lever--________________

FRONT-END LOADERS
UNIT XI

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1

(NOTE: If controls on equipment students use are different, make a diagram, label it, and substitute correct answers.)

A. 1. Boom--Lowered

   2. Control lever--C

   3. Bucket--Dumping

   4. Control lever--E

B. 1. Boom--Lowered

   2. Control lever--Neutral (C is also acceptable answer)

   3. Bucket--Retracting

   4. Control lever--A

C. 1. Boom--Raising

   2. Bucket--Retracting

   3. Control lever--H

D. 1. Boom--Raising

   2. Bucket--Dumping

   3. Control lever--F

FRONT-END LOADERS
UNIT XI

JOB SHEET #1--PERFORM PRESTART INSPECTION AND MAINTENANCE PROCEDURES

I. Equipment and materials

- A. Front-end loader
- B. Operator's manual
- C. Engine oil
- D. Engine coolant
- E. Hydraulic fluid
- F. Fuel
- G. Solvent
- H. Lubricants
- I. Grease gun
- J. Rags
- K. Tool kit

II. Procedure

(NOTE: Deficiencies should be corrected immediately or reported to the proper authority. Do not operate defective equipment.)

- A. Make a walk-around visual inspection for broken, worn, or missing parts, and leaks
- B. Check engine oil level; add or change oil if needed
- C. Check engine coolant level; add coolant if needed
- D. Check hydraulic reservoir level; add fluid if needed
- E. Check fuel level; fill tank if needed
- F. Check battery connections for tightness and corrosion
- G. Check battery electrolyte level; add water if needed

  (NOTE: Use distilled water rather than tap water.)
- H. Check air cleaner; remove and clean filter if needed
- I. Check brakes
- J. Check tires

K. Clean all grease fittings and lubricate according to manual

L. Check hydraulic system for leaking lines and connections, bent or kinked lines, and lines rubbing against other parts

M. Check drive belts for tightness

N. Check electrical wire connections and insulation

O. Clean windshield and mirrors; adjust mirrors

P. Check gauges

Q. Check foot pedals for proper functioning

R. Check levers and controls for proper functioning

S. Remove trash

T. Check lights

U. Check safety devices

V. Lubricate bucket pivots

W. On multipurpose bucket, scrape dirt packed between lower clam cylinder pivots and side of bucket

X. On articulated loader lubricate frame pivots

(NOTE: Lubricate every few hours when operating in extremely dusty conditions.)

Y. Tighten wheel retaining nuts

(NOTE: Retighten periodically during operation.)

FRONT-END LOADERS
UNIT XI

JOB SHEET #2--SERVICE A FRONT-END LOADER

I. Equipment and materials

A. Front-end loader

B. Operator's manual

C. Tool kit

D. Air supply

E. Grease gun

F. Lubricants

G. Cleaning solvent

H. Rags

I. Water

J. Engine coolant

K. Engine oil

L. Hydraulic fluid

M. Transmission fluid

N. Brake fluid

O. Tire pressure gauge

P. Fuel

II. Procedure

(NOTE: Follow departmental preventive maintenance program when servicing equipment. Refer to operator's manual for lubrication chart and service for specific components and attachments.)

A. Visually inspect for broken, worn, or missing parts, or leaks

(NOTE: Major repairs and replacements should be reported to the proper authority and completed by a trained mechanic.)

B. Check engine oil level, filter, lines and hoses; add or change oil or filter if needed

JOB SHEET #2

C. Check engine coolant level, radiator cap, hose, and radiator; add coolant if needed

(CAUTION: Do not remove radiator cap unless engine is cool; then, open cap slowly to release pressure.)

D. Clean air filter; replace as needed

E. Check fuel level, fuel filters, and sediment bowl (where applicable); fill fuel tank

F. Check battery electrolyte level, battery cables, and connectors; add water or electrolyte if needed

(NOTE: Keep sparks and fire away from battery.)

G. Check exhaust system for loose connections and holes

H. Check hydraulic fluid level, filters, hose, lines, and fittings and look for leaks; add fluid if needed

I. Check transmission fluid level; add fluid if needed

J. Check transmission pressure line filter and breather

K. Check brake adjustment and condition; adjust if needed

L. Check brake master cylinder fluid level; fill if needed

M. Check clutch adjustment; adjust when needed

N. Check drive belts and wear; adjust or replace if needed

O. Check wiring, insulation, and connections

P. Clean and lubricate grease fittings according to manual

Q. Check tire pressure; inflate to recommended pressure if needed

R. Check condition of tires

S. Check all safety devices; repair if needed

T. Check major components and/or accessories

FRONT-END LOADERS
UNIT XI

JOB SHEET #3--START, WARM UP, OPERATE, AND SHUT DOWN A FRONT-END LOADER

I. Equipment and materials

- A. Front-end loader
- B. Operator's manual

II. Procedure

- A. Mount machine, using steps and grab irons
- B. Sit in operator's seat and secure seat belt
- C. Check operator's manual for specific instructions
- D. Set parking brake if not already set
- E. Be sure all controls are in neutral
- F. Start engine

  (NOTE: Check operator's manual for procedures for cold-weather starting. Locate equipment on your machine.)

  1. Insert key in ignition
  2. Turn key to ON position
  3. Depress accelerator one-third total distance
  4. Press starter button

     (CAUTION: Never operate starter more than twenty seconds at a time. If engine fails to start, wait two to five minutes before cranking again.)

  5. Release key when engine starts

- G. Let engine warm up for five minutes
- H. Determine that all gauges and instruments are functioning properly

  (NOTE: If loader is equipped with clutch cutoff control, make sure it is in the ALWAYS ENGAGED position for this exercise.)

- I. Select gear range
- J. Shift to low gear
- K. Release parking brake and transmission locks if engaged

JOB SHEET #3

L. Move forward

M. Practice steering, stopping, and operating in reverse

(NOTE: Follow manufacturer's instructions for shifting to reverse and for changing gear ranges.)

N. Operate controls

1. Raise boom
2. Lower boom
3. Raise boom; dump bucket
4. Retract bucket
5. Practice combinations of steps 1-4

O. Drive loader to parking place

P. Stop loader

Q. Set parking brake

R. Lower bucket to ground

S. Shift gears to neutral positions

T. Set range selector in neutral position

U. Run engine at idle with no load for two to three minutes

(NOTE: This permits the engine to cool down and allows for gradual and uniform cooling of engine parts. It also prevents damage to the turbocharger by allowing it to slow down.)

V. Turn key to OFF position

W. Relieve hydraulic pressure

1. Operate all hydraulic control levers
2. Turn steering wheel back and forth

(CAUTION: Failure to relieve hydraulic pressure, particularly in an articulated loader, could lead to serious injury.)

X. Secure machine according to manufacturer's instructions

Y. Remove key

JOB SHEET #3

Z. Dismount, facing machine and using grip handles

(NOTE: Be aware of slippery conditions on steps and on the ground.)

AA. Make final visual check around front-end loader for leaks, worn, missing, or broken parts.

(NOTE: Report any deficiencies to proper authority.)

FRONT-END LOADERS
UNIT XI

JOB SHEET #4--PERFORM DIGGING OPERATIONS

I. Equipment--Front-end loader

II. Procedure

A. Mount machine, using steps and grab irons

B. Sit in operator's seat and secure seat belt

C. Raise bucket 12 to 18 inches above ground (travel position)

D. Pull bucket control lever to tilt bucket

E. Release hand brake

F. Shift to appropriate gear

G. Depress accelerator pedal and proceed to job site

H. Move bucket control lever to scoop position

I. Lower bucket to ground and move forward

(CAUTION: Do not spin wheels.)

J. Manipulate bucket until it is loaded

K. Place bucket and boom control levers on "hold" when bucket is filled

L. Shift gears to reverse; back up loader

M. Position bucket in travel position (12 to 18 inches above ground); proceed to dumping area

N. Move bucket control lever forward to dump bucket, and at same time pull boom control lever to retract bucket

O. Pull bucket control lever to retract empty bucket, and at same time back loader away from pile

P. Position bucket in travel position; return to excavation

Q. Repeat cycle until excavation is completed

R. Shut down machine

S. Dismount, using steps and grab irons

FRONT-END LOADERS
UNIT XI

JOB SHEET #5--PERFORM LOADING OPERATIONS

I. Equipment and materials

- A. Front-end loader
- B. Dump truck
- C. Stockpile or snowdrift

  (NOTE: A front-end loader is often used to load snow onto trucks for disposal. Follow loading operation procedures.)

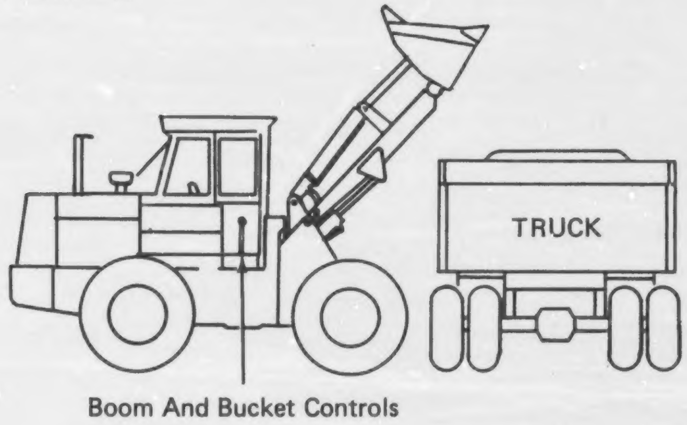
II. Procedure

- A. Mount machine, using steps and grab irons
- B. Sit in operator's seat and secure seat belt
- C. Raise bucket to travel position (12 to 18 inches above ground)
- D. Pull bucket control lever to tilt bucket
- E. Release hand brake
- F. Shift to appropriate gear
- G. Depress accelerator pedal; proceed to job site
- H. Manipulate control levers for appropriate bucket position
- I. Move loader into stockpile
- J. Adjust controls and brake pedal as required to fill bucket
- K. Place bucket and boom control levers on "hold" when bucket is filled
- L. Shift gears to reverse
- M. Back loader away from stockpile
- N. Place bucket in travel position (12 to 18 inches above ground); move loader to truck
- O. Center loader with truck bed; raise bucket to clear side of truck just as you reach the truck

JOB SHEET #5

P. Position bucket over truck bed (Figure 17)

FIGURE 17



Used with permission of Deere & Company, Moline, Illinois.

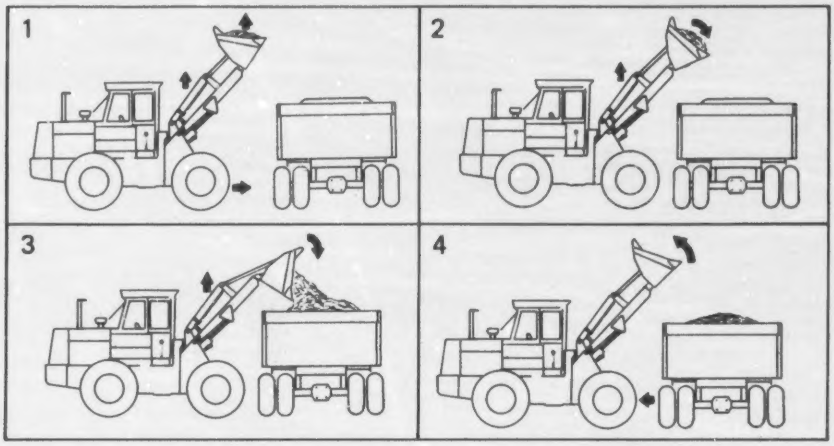
Q. Raise boom and dump bucket at the same time

R. Retract empty bucket; back loader away from truck as soon as bucket is empty

S. Lower bucket to travel position; return to stockpile

T. Repeat cycle until truck is loaded (Figure 18)

FIGURE 18



U. Shut down machine

V. Dismount, using steps and grab irons

FRONT-END LOADERS
UNIT XI

JOB SHEET #6--PERFORM DOZING OPERATIONS

I. Equipment and materials

   A. Front-end loader

   B. Excavation area

   C. Stockpile

II. Procedure

   A. Mount machine, using steps and grab irons

   B. Sit in operator's seat and secure seat belt

   C. Raise bucket to travel position (12 to 18 inches above ground)

   D. Pull bucket control lever to tilt bucket

   E. Release hand brake

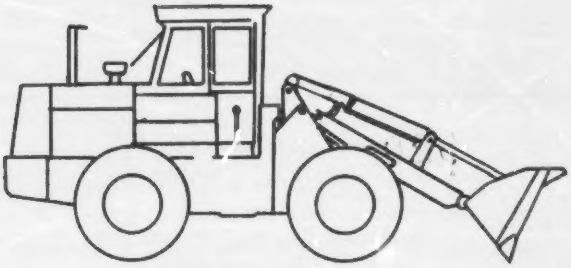
   F. Shift to appropriate gear

   G. Depress accelerator pedal; proceed to job site

   H. Move boom control lever forward; position bucket on ground

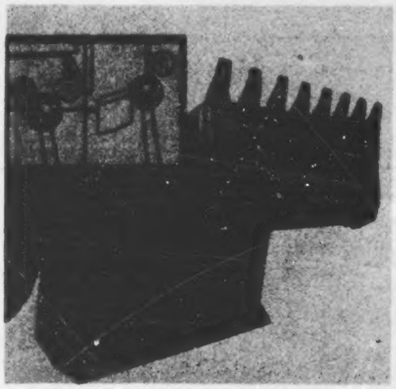
   I. Move bucket control lever to adjust bucket to dozer position (Figures 19 and 20)

FIGURE 19



Standard Bucket in Dozer or Grade Position

FIGURE 20



Multipurpose bucket in Dozer Position

Figure 20 courtesy of Deere & Company, Moline, Illinois.

JOB SHEET #6

J. Shift to appropriate gear

K. Depress accelerator pedal; proceed to stockpile

L. Push material to fill area with bucket, adjusting controls as necessary for correct blade level

M. Return to stockpile; repeat cycle until fill is complete

N. Shut down machine

O. Dismount, using steps and grab irons

FRONT-END LOADERS
UNIT XI

JOB SHEET #7--DIG A PIT

I. Equipment and materials

  A. Front end-loader

  B. Area staked with string line set

II. Procedure

  A. Mount machine, using steps and grab irons

  B. Sit in operator's seat and secure seat belt

  C. Raise bucket to travel position (12 to 18 inches above ground)

  D. Release brake and transmission locks

  E. Set throttle to desired engine speed

  F. Shift to appropriate gear

  G. Travel to job site

  H. Align loader bucket edge approximately 12 inches inside string line

  I. Lower bucket to ground, making sure the loader is well back from excavation; tilt cutting edge down to load bucket

  J. Retract bucket when machine begins to stall

  K. Raise boom control and continue loading bucket

  L. Place bucket and boom control levers on "hold" when bucket is full

  M. Back loader up ramp; travel to dump area

  N. Raise boom; dump bucket

  O. Lower boom to travel position; travel back to excavation

  P. Repeat cycle until proper depth is reached

  Q. Lower boom and bucket to proper cutting angle

  R. Begin cutting a level ditch

  S. Continue cycle until area inside string line is completely excavated to proper depth

  T. Shut down machine

  U. Dismount, using steps and grab irons

FRONT-END LOADERS
UNIT XI

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with front-end loaders to their correct definitions. Write the correct numbers in the blanks.

______a. To refill a ditch or other excavation; material used for refilling

______b. Hydraulic cylinder

______c. Device for holding a lever in position

______d. Jointed

______e. To travel equipment under its own power

______f. Materials put into a pile and saved for future use

______g. Exhaust-driven centrifugal air compressor used to increase engine power

______h. To travel equipment by loading it on another vehicle

______i. Raising elevation of the ground to desired level; soil material

______j. To repeat the same steps or procedures

______k. Attachments used to increase a machine's versatility and effectiveness

______l. Gear position that allows bucket to follow the contour of the surface

1. Fill
2. Stockpile
3. Articulated
4. Ram
5. Transport
6. Cycle
7. Accessories
8. Backfill
9. Float
10. Detent
11. Turbocharger
12. Road

2. Select from the following list the types of jobs performed with front-end loaders. Write an "X" in the blank before each correct answer.

______a. Backfilling

______b. Forwardfilling

______c. Digging

______d. Finish grading

TEST

______e. Rough grading

______f. Digging trenches

______g. Cutting lines

______h. Hauling materials and equipment

______i. Removing trees

______j. Winching equipment

______k. Removing snow

______l. Stockpiling

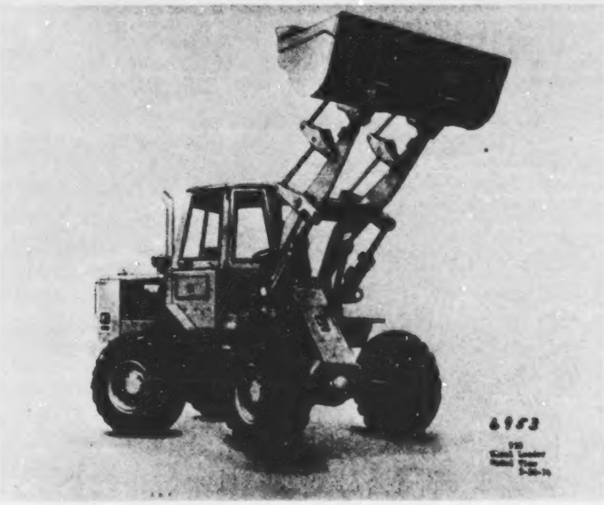
______m. Mowing

______n. Loading trucks

______o. Lifting personnel

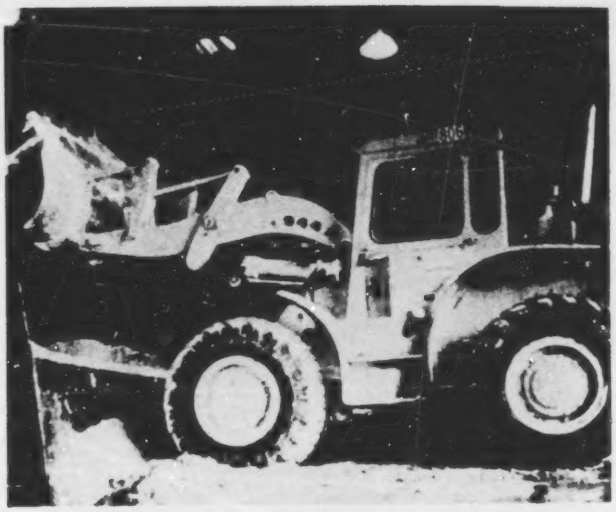
3. Identify types of front-end loaders. Write the correct names in the blanks.

Articulated wheel loader
Crawler loader
Rigid-frame wheel loader

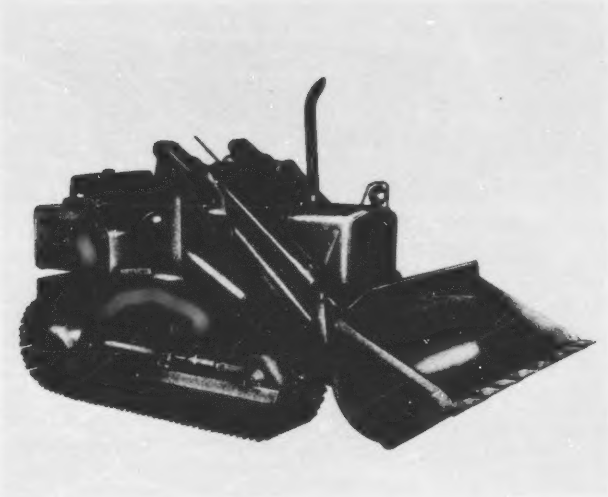


a. ______________________________

TEST



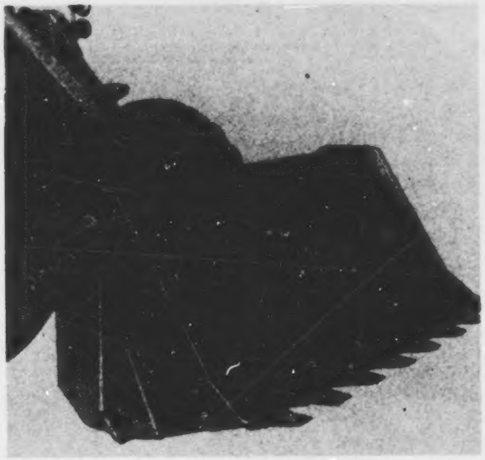
b. ______________________________



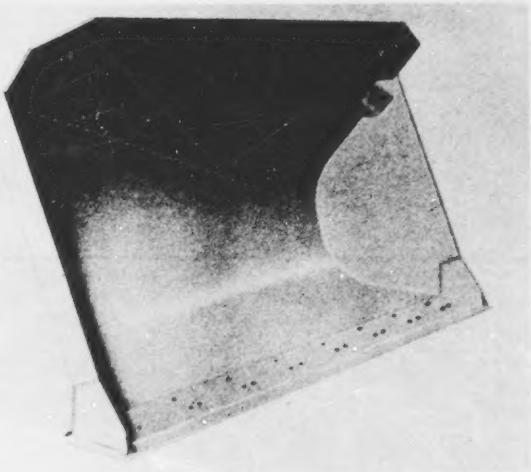
c. ______________________________

TEST

4. Label accessories used on front-end loaders. Write the correct names in the blanks.



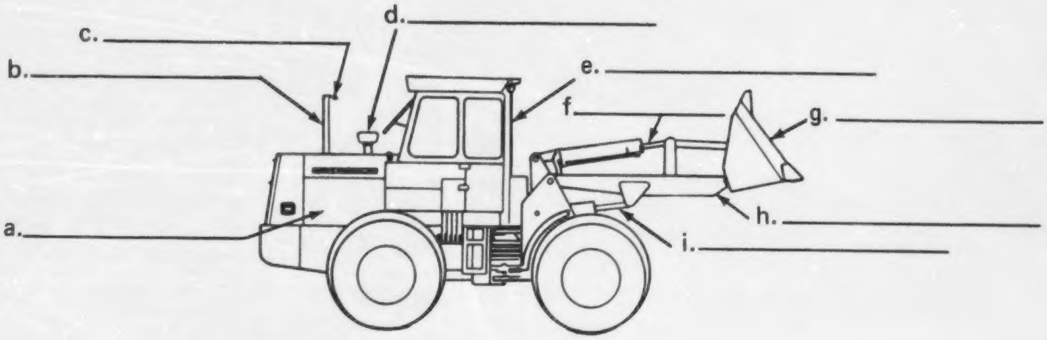
a. ______________________________



b. ______________________________

TEST

5. Label basic parts of a wheel loader. Write the correct names in the blanks.



TEST

6. Identify controls on a typical front-end loader. Write the correct numbers in the blanks.

______a. Key switch

______b. Starter button

______c. Shift lever

______d. Diesel starting fluid adapter

______e. Accelerator

______f. Parking brake

______g. Brake pedals

______h. Axle disconnect (located behind seat)

______i. Clutch cutoff control lever (located on side of seat)

______j. Range indicator

______k. Engine oil pressure gauge

______l. Ammeter

______m. Engine coolant temperature gauge

______n. Transmission pressure gauge

______o. Transmission temperature gauge

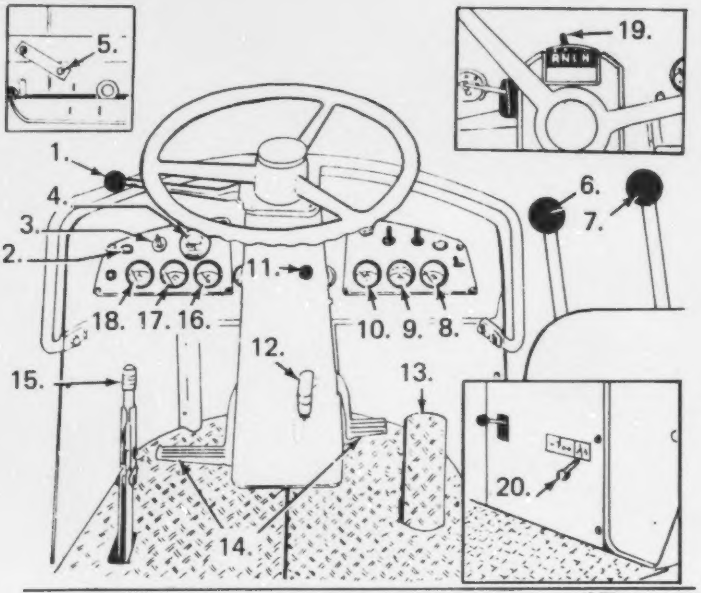
______p. Fuel gauge

______q. Horn button

______r. Attachment control lever

______s. Boom-bucket control lever

______t. Hourmeter



TEST

7. Match controls on a typical front-end loader to their correct functions. Write the correct numbers in the blanks.

______a. Aids in cold-weather starting

______b. Selects gears

______c. Speeds loading operations by disconnecting transmission clutches when brake pedal is depressed

______d. Disengages rear axle for maximum speed when roading loader

______e. Stops loader

______f. Shows reverse, neutral, high or low gear range selected

______g. Controls engine rpm and travel speed

______h. Secures loader when engine is idling or when loader is parked

______i. Controls four-in-one bucket or other types of auxiliary equipment

______j. Controls height and direction of boom and bucket

1. Brake pedal
2. Parking brake
3. Range indicator
4. Accelerator
5. Axle disconnect
6. Attachment control lever
7. Clutch cutoff control lever
8. Boom-bucket control lever
9. Diesel starting fluid adapter
10. Shift lever

8. Identify typical boom and bucket control positions. Write the correct letters in the blanks.

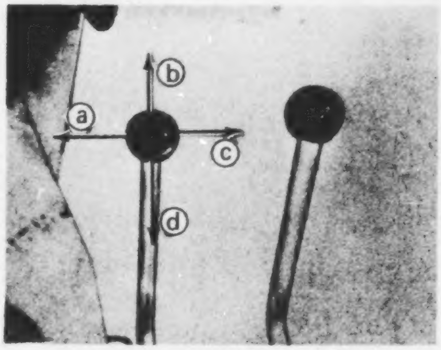
a. Standard operation

______1) Lower boom

______2) Raise boom

______3) Retract bucket

______4) Dump bucket

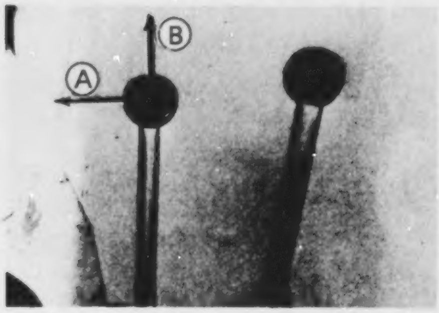


TEST

b. Detent operation

_____1) Float position detent

_____2) Return-to-dig detent



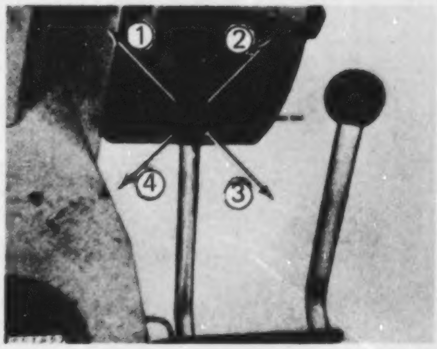
c. Boom and bucket combined

_____1) Lower boom--Retract bucket

_____2) Raise boom--Dump bucket

_____3) Raise boom--Retract bucket

_____4) Lower boom--Dump bucket



9. Match four-in-one (multipurpose) bucket functions to their correct uses. Write the correct numbers in the blanks.

_____a. Used for pushing soil and materials, stockpiling, moving stumps and rocks

_____b. Used for standard front-end loader operations

_____c. Used for leveling and grading

_____d. Used for picking up materials from an overhead position

1. Bucket
2. Dozer
3. Clamshell
4. Scraper

TEST

10. State ten safety rules for operating a front-end loader.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

i. ____________________

j. ____________________

11. Select from the following list suggestions for effective loader operations. Write an "X" in the blank before each correct answer.

_____a. Fill truck gradually from near side to far side

_____b. Raise the boom slowly so that the bucket will just reach dumping height at the time it arrives at the dump area

_____c. Keep distance from load to dump as short as possible

_____d. When transporting loader, cover rain cap to protect turbocharger

_____e. Keep boom at maximum height when traveling at higher speeds

_____f. Fill truck gradually from far side to near side

_____g. Load with wind at your back when possible

_____h. Raise boom to maximum height before dumping

_____i. Plan work cycle so that it will be as short as possible

_____j. If possible, carry loaded bucket downhill when traveling on an incline

_____k. If possible, carry loaded bucket uphill when traveling on an incline

_____l. Carry bucket with approximately 18 inches clearance when traveling with an empty bucket

_____m. Lower boom to transport position as soon as bucket clears obstacles at dump site

TEST

______ n. Carry bucket just high enough to clear obstacles when transporting a load

______ o. Load into the wind when possible

______ p. Perform all prestart inspection and service procedures

______ q. When transporting loader, cover exhaust pipe to protect turbocharger

12. Select from the following list procedures for digging. Write an "X" in the blank before each correct answer.

______ a. Use bucket cylinder to break ground loose rather than using only forward movement of the loader

______ b. Do not push into solid obstructions with bucket at a steep angle

______ c. Level terrain whenever possible

______ d. Use only sufficient bucket digging angle to fill bucket easily

______ e. Ram obstacles with bucket in flat position

______ f. Use as flat a ramp as possible when starting an excavation

______ g. Cut into hard ground by tipping the bucket downward 20 to 40 degrees

______ h. Do not raise bucket higher than necessary to fill it

______ i. Have bucket flat or tilted slightly downward

______ j. Cut into hard ground by tipping the bucket downward 10 to 30 degrees

______ k. Retract bucket when loaded; raise boom for 18-inch clearance

13. State six procedures for loading.

a. ____

b. ____

c. ____

d. ____

e. ____

f. ____

TEST

14. Select from the following list procedures for leveling and grading. Write an "X" in the blank before each correct answer.

    _____a. Rough grade by running loader with bucket open and lever in dig-in detent postion

    _____b. Rough grade by filling holes and low places and loosening high places

    _____c. Let material spill from partly open bucket held close to the ground for even spread

    _____d. Finish grade by running loader in reverse with bucket open and control lever in float position

    _____e. Clear high places before filling holes and low places

(NOTE: Test questions 15 and 16 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

15. List in order lever positions for loading operations.

16. Demonstrate the ability to

    a. Perform prestart inspection and maintenance procedures.

    b. Service a front-end loader.

    c. Start, warm up, operate, and shut down a front-end loader.

    d. Perform digging operations.

    e. Perform loading operations.

    f. Perform dozing operations.

    g. Dig a pit.

FRONT-END LOADERS
UNIT XI

ANSWERS TO TEST

1.

a.	8	d.	3	g.	11	j.	6
b.	4	e.	12	h.	5	k.	7
c.	10	f.	2	i.	1	l.	9

2. a, c, d, e, h, k, l, n

3. a. Articulated wheel loader
   b. Rigid-frame wheel loader
   c. Crawler loader

4. a. Four-in-one bucket (multipurpose bucket)
   b. Standard bucket

5. a. Engine
   b. Exhaust pipe
   c. Rain cap
   d. Air intake
   e. Rollover protective structure (ROPS)
   f. Tilt ram
   g. Bucket
   h. Boom
   i. Lift ram

6.

a.	3	f.	15	k.	8	p.	16
b.	2	g.	14	l.	9	q.	11
c.	1	h.	5	m.	10	r.	7
d.	12	i.	20	n.	17	s.	6
e.	13	j.	19	o.	18	t.	4

ANSWERS TO TEST

7. a. 9
   b. 10
   c. 7
   d. 5
   e. 1
   f. 3
   g. 4
   h. 2
   i. 6
   j. 8

8. a. Standard operation
      1) B
      2) D
      3) A
      4) C
   b. Detent operation
      1) B
      2) A
   c. Boom and bucket combined
      1) A
      2) C
      3) D
      4) B

9. a. 2
   b. 1
   c. 4
   d. 3

10. Answer should include any ten of the following
    a. Read operator's manual thoroughly; know your machine
    b. Study departmental safety regulations

ANSWERS TO TEST

c. Wear close-fitting clothing

d. Do not permit unauthorized people in work area while equipment is operating

e. Travel at safe operating speeds

f. Make sure all warning devices are working properly

g. Always use warning signs and proper control procedures

h. Keep bucket as close to the ground as possible when transporting loads

i. Lower bucket to the ground when the loader is stopped or unattended

j. Check all component hinge pins and their devices frequently

k. Never perform service or repairs on equipment that has not been properly blocked, tagged, and secured

l. Follow departmental preventive maintenance program when servicing equipment

m. When servicing, repairing, or transporting an articulated loader, be sure to insert locking pin

n. Never lift the bucket over the ground crew

o. Never swing the bucket over the truck cab

p. Release hydraulic pressure from an articulated loader by moving the steering wheel back and forth after the machine is shut down

q. Use extra caution when conditions require it

11. b, c, d, f, g, i, k, m, n, p

12. a, b, d, f, h, i, j

13. Answer should include any six of the following

    a. Keep bucket low when carrying a load

    b. Always watch for material falling off the back of the bucket when the bucket is in a high position

    c. Raise bucket when moving toward truck

    d. Dump bucket when it is over the bed

ANSWERS TO TEST

e. Back up and retract bucket as soon as dumping is complete

f. Lower bucket when moving away from truck

g. Keep working areas smooth

h. Use "V" loading method to minimize turning

i. Shake bucket only when necessary to loosen material lodged in bottom

14. b, c, d

15. Evaluated to the satisfaction of the instructor

16. Performance skills evaluated to the satisfaction of the instructor